



CALIFORNIA  
ENERGY  
COMMISSION

## NEW GEOTHERMAL SITE IDENTIFICATION AND QUALIFICATION

# CONSULTANT REPORT

*Prepared For:*

**California Energy Commission**  
Public Interest Energy Research Program

*Prepared By:*

**Geothermex, INC.**

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Arnold Schwarzenegger, Governor

# CALIFORNIA ENERGY COMMISSION

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## PREFACE

The Public Interest Energy Research (PIER) Program supports public interest energy research and development that will help improve the quality of life in California by bringing environmentally safe, affordable, and reliability energy services and products to the marketplace.

The PIER Program, managed by the California Energy Commission (the Commission, Energy Commission), annually awards up to \$62 million to conduct the most promising public interest energy research by partnering with Research, Development, and Demonstration (RD&D) organizations, including individuals, businesses, utilities, and public or private research institutions.

PIER funding efforts are focused on the following six RD&D program areas:

- Residential and Non-Residential Buildings End-Use Energy Efficiency
- Industrial, Agricultural, and Water End-Use Energy Efficiency
- Renewable Energy Technologies
- Environmentally Preferred Advanced Generation
- Energy-Related Environmental Research
- Strategic Energy Research

What follows is the final report for the New Geothermal Site Identification and Qualification Project, part of the Hetch Hetchy/SFPUC Programmatic Renewable Energy Project. GeothermEx, Inc., has prepared this report under contract to the City and County of San Francisco (the City), San Francisco Public Utilities Commission, Hetch Hetchy Water and Power Division, pursuant to Agreement Number CS-706.D between GeothermEx and the City. The Energy Commission has funded the work pursuant to the PIER Program Contract Number 500-01-042 between the City and the Energy Commission.

For more information on the PIER Program, please visit the Commission's web site <http://www.energy.ca.gov/pier/reports.html> or contact the Commission Publication Unit at (916) 654-5200.





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### **Attachment**

PIER Geothermal Database (MS Access©).....CD in pocket

## **ABSTRACT**

This study identifies remaining undeveloped geothermal resources in California and western Nevada, and it estimates the development costs of each. It has relied on public-domain information and such additional data as geothermal developers have chosen to make available. Reserve estimation has been performed by volumetric analysis with a probabilistic approach to uncertain input parameters. Incremental geothermal reserves in the California/Nevada study area have a minimum value of 2,800 gross MW and a most-likely value of 4,300 gross MW. For the state of California alone, these values are 2,000 and 3,000 gross MW, respectively. These estimates may be conservative to the extent that they do not take into account resources about which little or no public-domain information is available. The average capital cost of incremental generation capacity is estimated to average \$3,100/kW for the California/Nevada study area, and \$2,950/kW for the state of California alone. These cost estimates include exploration, confirmation drilling, development drilling, plant construction, and transmission-line costs. For the purposes of this study, a capital cost of \$2,400/kW is considered competitive with other renewable resources. The amount of incremental geothermal capacity available at or below \$2,400/kW is about 1,700 gross MW for the California/Nevada study area, and the same amount (within 50-MW rounding) for the state of California alone. The capital cost estimates are only approximate, because each developer would bring its own experience, bias, and opportunities to the development process. Nonetheless, the overall costs per project estimated in this study are believed to be reasonable.



## EXECUTIVE SUMMARY

The Hetch Hetchy Water and Power Division of the San Francisco Public Utilities Commission (Hetch Hetchy/SFPUC) has retained GeothermEx, Inc., to provide a portfolio of well-characterized geothermal resources within California and western Nevada that could supply additional power to the California market. This project (Project 1.3) is the geothermal component of the Hetch Hetchy/SFPUC Programmatic Renewable Energy Project, a set of PIER-funded studies to evaluate the potential of a variety of renewable energy sources and options for energy transmission.

The objective of Project 1.3 is to quantify each geothermal resource in terms of its minimum and most-likely generation capacity, estimated costs of exploration and confirmation, and estimated total development costs and unit development costs (\$/kW installed), including transmission-line costs as determined by other Hetch Hetchy/SFPUC project participants. Project 1.3 has relied on information in the public domain and such other information as private developers have agreed to contribute. A principal outcome of the work has been the creation of a database (referred to herein as the PIER Geothermal Database) in MS Access®, included on a computer CD accompanying this study. The PIER Geothermal Database includes information about the resource characteristics of 155 separate geothermal projects at 83 resource areas. It also includes embedded documents describing the methodology of the study and tables summarizing results.

To establish a quick way of ranking geothermal projects at varying stages of maturity, this study has defined four development categories as follows:

- A – Existing power plant operating
- B – One or more wells tested with a potential greater than or equal to ( $\geq$ ) 1 MW, but no power plant in operation
- C – Minimum 212°F logged downhole, but no well tests at  $\geq$  1 MW
- D – Other exploration data and information available ( $\geq$  212°F not proven)

The geothermal projects have also been classified geographically into four areas to facilitate consideration of options for transmission of power to the California market:

- Area 1 – Greater Reno, Nevada (including nearby California sites at Honey Lake)
- Area 2 – Nevada sites with direct access to the California grid (the Dixie Corridor)
- Area 3 – Other Nevada locations
- Area 4 – All California locations (excluding Honey Lake)

The results of this study are presented by grouping fields according to these areas. Results are also summarized by state (that is, all California fields and all Nevada fields). Minimum and most-likely estimates of electrical generation capacity have been made for 58 resource areas that have sufficient information in the public domain. The estimates are based on a methodology that has been used by GeothermEx over the past two decades. This methodology is a volumetric reserve estimation approach introduced by the U. S. Geological Survey, modified to account for uncertainties in some input parameters by using a probabilistic basis (Monte Carlo simulation).

Based on the reserve estimates of this study, the electrical generation capacity available to the California market from geothermal sources in California and Nevada has a minimum value of about 4,700 gross MW and a most-likely value of about 6,200 gross MW. After allowances for generation capacity already on line, the incremental generation capacity available from geothermal sources in both states has a minimum value of about 2,800 gross MW and a most-likely value of about 4,300 gross MW. These estimates may be conservative to the extent that they do not take into account resources about which little or no public-domain information is available.

The generation capacity available from fields within California alone has a minimum value of about 3,700 gross MW and a most-likely value of about 4,700 gross MW. The incremental generation capacity available from fields within California alone has a minimum value of about 2,000 gross MW and a most-likely value of about 3,000 gross MW. Geothermal sites in California alone account for about 70% of the combined incremental generation capacity available from both states. Within California, 90% of the incremental generation capacity identified in this study comes from three areas: the Imperial Valley, The Geysers, and Medicine Lake. The Imperial Valley alone accounts for about 65% of the incremental capacity available in California.

For the geothermal sites in both states, the capital cost of incremental generation capacity averaged about \$3,100 per kW installed. For California sites alone, the average capital cost of incremental generation capacity was somewhat lower: about \$2,950 per kW installed. These cost estimates include the following components:

- Exploration (up to the siting of the first deep, commercial-diameter hole);
- Confirmation drilling (up to achieving 25% of required capacity at the wellhead);
- Development drilling (up to achieving 105% of required capacity at the wellhead);
- Construction of the power plant (including ancillary site facilities); and
- Transmission-line costs.

The capital cost estimates are only approximate, because each developer would bring its own experience, bias, and opportunities to the development process. Nonetheless, the overall costs per project estimated in this study are believed to be reasonable.

The capital cost for specific geothermal projects ranged from about \$1,000/kW (for a small expansion at an existing project) to values in excess of \$6,000/kW (for deep, low-temperature resources at remote locations). Of the 4,300 gross MW of most-likely incremental capacity available from both California and Nevada, about 2,500 gross MW is available at a capital cost less than the average of \$3,100/kW. Considering just fields within California, about 2,000 gross MW of incremental generating capacity is available at a capital cost below the average of \$2,950/kW.

For the purposes of this study, a capital cost of \$2,400/kW or less is considered competitive with other renewable resources, both for the California/Nevada study area and for the state of California alone. The amount of incremental geothermal capacity available at or below \$2,400/kW is about 1,700 gross MW for the California/Nevada study area, and the same amount (after rounding to the nearest increment of 50 gross MW) for the state of California alone. This amount of geothermal capacity available represents a significant opportunity for commercial

development to meet the needs of the California electricity market. Resources with higher estimated costs may also be attractive, depending on market conditions and the mechanisms for implementing California's renewable portfolio standard.





## **1.0 Introduction**

### **1.1. Background and Overview**

There are several obstacles to new geothermal development in California and Nevada. One of the most significant is a perception that the largest and most accessible resources (such as The Geysers, Salton Sea, and Coso) have already been developed. The majority of known resource sites that remain in California and Nevada either have smaller capacities or present special economic challenges. These remaining projects have been historically of less interest to developers due to associated high up-front costs.

### **1.2. Project Objectives**

#### **1.2.1. Introduction to Project 1.3**

The Hetch Hetchy Water and Power Division of the San Francisco Public Utilities Commission (Hetch Hetchy/SFPUC) has retained GeothermEx, Inc., to provide a portfolio of well-characterized geothermal resources within California and western Nevada that could supply additional power to the California market. Project 1.3 is the geothermal component of the Hetch Hetchy/SFPUC Programmatic Renewable Energy Project, a set of PIER-funded projects that are gathering data and evaluating the potential of a variety of renewable energy sources (geothermal, wind, solar, biomass, etc.) and options for energy transmission in California and parts of Nevada that have the potential to supply the California market. A companion to Project 1.3 is Project 2.1 (Existing Geothermal Facility Improvements), which is scheduled for completion in November 2004.

#### **1.2.2. Project Goals**

The goal of Project 1.3 has been to compile the most accurate information available in the public domain on remaining undeveloped geothermal resources in California and western Nevada. The intention is to make this information easily accessible to entities interested in developing or purchasing geothermal power, including municipal power agencies and investor-owned utilities. In combination with other studies in the Hetchy/SFPUC Programmatic Renewable Energy Project, Project 1.3 is intended to facilitate aggregation of undeveloped renewable resources so as to achieve greater economies of scale. It is hoped that this information will help make possible a significant new phase of geothermal resource development in the United States and an increase in the number of entities participating in geothermal projects.

It is anticipated that the portfolio of geothermal projects described in this report will be evaluated with other potential energy sources in the same geographic areas, to seek options for the collocation of power generation facilities with shared transmission facilities and coordinated base-load and peaking power generation. The result will be an increase in renewable generation and further diversification of the power mix.

#### **1.2.3. Project Objectives**

The objective of Project 1.3 has been to quantify the geothermal resources in California and western Nevada in terms of minimum and most-likely generation capacities, estimated costs of exploration and confirmation, and estimated total development costs and unit development costs (\$/kW installed), including transmission tie-in costs as determined by other participants in the Hetch Hetchy/SFPUC Programmatic Renewable Energy Project. The portfolio of

geothermal resources described in this study (referred to herein as the Project Portfolio) includes areas both with and without existing power plants. For those resources with existing plants, Project 1.3 includes an estimate of the quantity and cost of the incremental generation capacity available.

### **1.3. Report Organization**

Chapter 2 of this report describes the specific background and baseline conditions of Project 1.3, along with Project work plans, the geographic area of interest, the Project Task List, and the MS Access© database of geothermal resource information (referred to herein as the PIER Geothermal Database).

Chapter 3 describes the project outcomes, including overviews of the resource data compiled, the methodologies employed, and estimates of generation capacities and development costs.

Chapter 4 provides the conclusions and recommendations obtained from the project outcomes, along with comments regarding commercialization potential and benefits to California.

Chapter 5 contains endnotes from Chapters 1 to 4.

Chapter 6 contains project references in bibliographic format, divided into (1) general references (relevant to background information and methodologies) and (2) the geo-technical references that are specific to the various geothermal projects<sup>1</sup>.

Chapter 7 is a glossary of terms, abbreviations and definitions used in the text of this report and in the PIER Geothermal Database.

This is followed by figures, tables, appendices, and (on an attached computer CD) the PIER Geothermal Database.

The PIER Geothermal Database in MS Access© contains embedded illustrations and automated reports that allow the user to view and print geotechnical data and calculated results for each geothermal resource site in the Project Portfolio. The text of this report includes only one illustrative example of the following<sup>2</sup>:

- a. Project Data Summary Report
- b. Local Site Area Map
- c. Local Site Downhole Temperature Graph
- d. Probabilistic Calculation Of Geothermal Energy Reserves
- e. Cost Summary Entitled Exploration, Confirmation And Development Costs – Detail By Project

Summaries and documents describing methodology are included as tables and appendices to this report, and are accessible as reports within the PIER Geothermal Database. The narrative content of Chapters 2 through 4 provides an overview of each topic and results, with reference to the full detail contained in corresponding tables and appendices.

## **2.0 Project Approach**

### **2.1. Prior Research**

This project has used prior research, exploration, and development results in the public domain to the fullest extent possible. This includes:

Published sources such as technical, trade and academic journals and reports of government-sponsored projects and research (see References in Chapter 6)

Information available at a number of internet locations, including vast collections of temperature data from shallow and deep holes in California and Nevada that have been compiled by the USGS <sup>3</sup> (USGSOF99-425) and by Southern Methodist University (SMUWGD), as well as fluids chemistry information compiled by the USGS (GEOTHERM)

Public domain information on several projects available from the files of INEEL

Data and information received from developers of some of the geothermal projects and released into the public domain specifically in connection with this study. All known developers of projects within the geographic area of the study were contacted with information about the PIER project and a request for data and information. To various degrees, some chose to supply previously unavailable data and information, whereas others did not.

To the full extent of GeothermEx's knowledge, proprietary (unpublished, privately held) information and data have not been included in the database, and do not contribute in a direct way to any of the conclusions and recommendations of this study. However, GeothermEx has used its extensive experience in the geothermal industry to help guide the methodologies used and selections made between some of the alternative possible conclusions and recommendations.

### **2.2. Baseline Conditions**

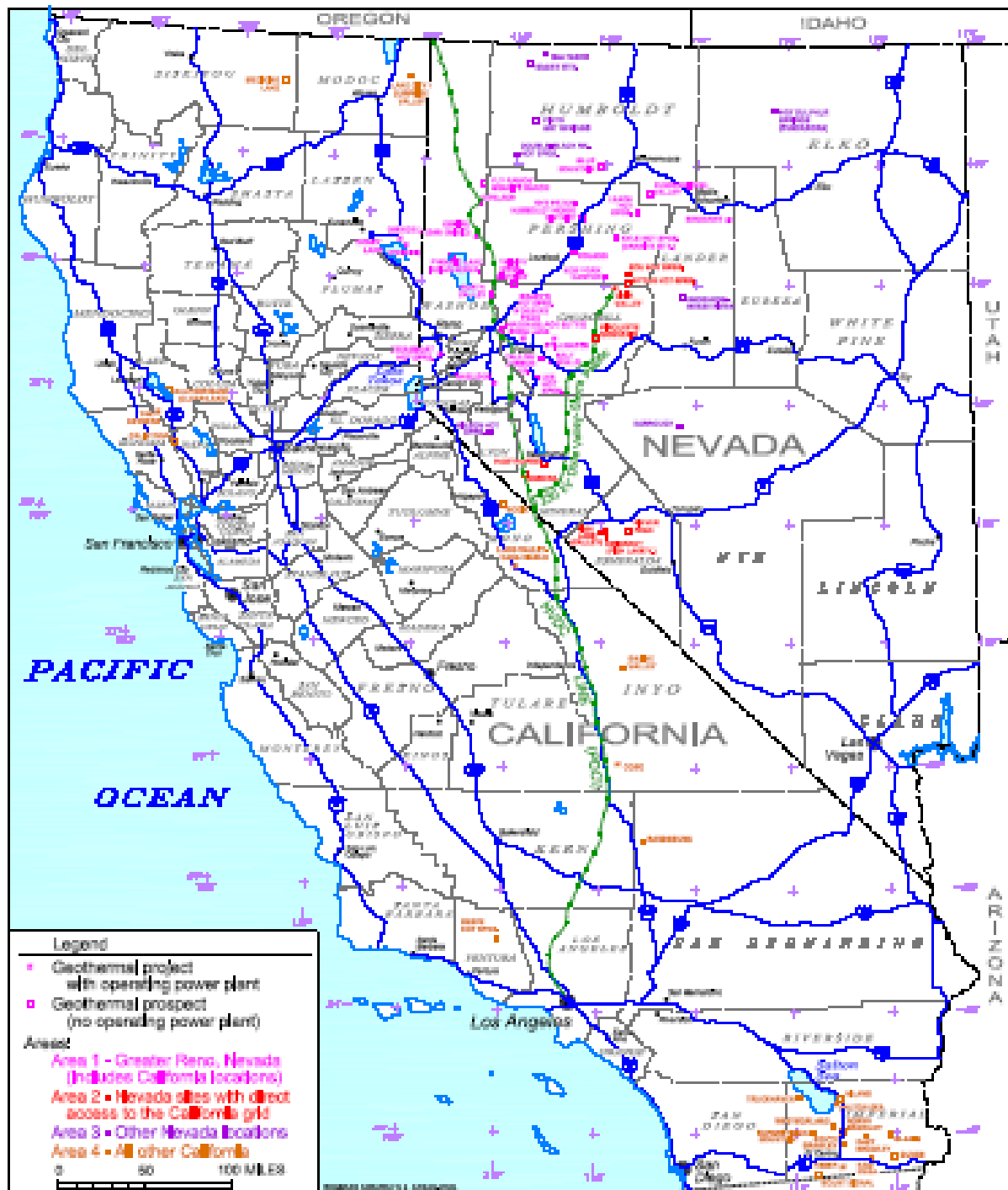
There have been three baseline conditions for inclusion of a geothermal resource area in the portfolio of projects with electricity generation potential. These are geographic location, resource temperature, and evidence of a discrete resource.

The PIER Geothermal Database is confined to resources within the geographic area that is described below, but it does list some resources that have been excluded from the portfolio (*i.e.*, generation capacity and exploration-to-development costs have not been estimated). In such cases either: (a) the area in question is a geographic (or technical/economic) subdivision of another area, for which estimates are made, or (b) one or both of the temperature and discrete resource criteria were found to be lacking. These latter usually are resource areas that have been listed by others as having interest for exploration and/or development, but which did not meet the criteria of this project.

#### **Geographic Location**

The subject area of Project 1.3 (see Figure 1 and section 2.4) has been:

- The Entire State Of California, And
- The Western Part Of The State Of Nevada (Extending As Far East As The Beowawe Project Near Battle Mountain).



**Figure 1 Locations of Geothermal Resource Areas**

At the start of Project 1.3, resource areas in Nevada were included only if located within 50 miles of the High-Voltage Direct-Current (HVDC) transmission line (“HVDC intertie”) that runs north from Los Angeles into eastern California, through western-most Nevada, and into Oregon (see Figure 1 and section 2.4). (The HVDC intertie is also known as the Pacific Direct-Current Intertie, or PDCI). It was later decided to include other locations in western Nevada,

because some are along or very close to other transmission lines that could provide access to the California market. Because it would be arbitrary to select an exact cut-off distance from existing transmission, all resources as far east as Beowawe were eventually included.<sup>4</sup>

Section 2.4 describes subdivisions of the subject area.

### **Resource Temperature**

An estimate of generation capacity and exploration-to-development cost has been made only if it has been concluded that the average temperature of the resource is reasonably likely to be at least 212°F. This low cut-off temperature results in the inclusion of a number of marginal, very small resources. However, these resources can be economically viable: witness the Wabuska project in Nevada (WAB005), which started production in 1984 and continues to generate electricity from a resource at about 220°-227°F.

There are some projects that have not been drilled enough to establish the resource temperature, and in such cases it is assumed that an average of temperatures found elsewhere can be applied (this is described in Appendix III). However, if there is relatively good evidence that 212°F is not attained, then the area has been excluded from further consideration.

### **Evidence Of A Discrete Resource**

To be included in the Project Portfolio, it is necessary that a resource be somehow discretely defined in terms of proven or probable geographic extent (even if fairly uncertain). The database lists a few geothermal resource areas that have been listed by others as having interest for further exploration and development. Some of these are fairly broad regions in which anomalous temperatures exist at scattered locations, but no specific anomaly has yet attracted focused exploration and development. Examples are the Carson Sink in Nevada and Westmorland in California. Generation capacity and exploration-to-confirmation cost estimates have not been made for these areas, so they are not considered to be part of the portfolio.

## **2.3. Project Work Plans**

### **Estimated Generation Capacity (see section 3.2 and Appendix III)**

The amount and quality of technical data available from the various geothermal resource areas is highly variable. Some areas have existing facilities with long production histories that can allow a reasonably accurate assessment of the ultimate potential of the field, setting the stage for possible capacity expansion, or indicating that further expansion is unlikely. Others have enough drilling information to prove the existence of commercial production conditions, and even with no production history it is possible to determine the resource criteria needed to estimate probable generation capacity. At the other end of the spectrum are sites where a geothermal resource has been identified from surface exploration, but no deep drilling has been conducted to confirm the presence of a commercial reservoir.

To carry out the resource assessment in the face of this database disparity, the project has quantified for each site a uniform set of required resource criteria that determine commercial feasibility. For some projects these criteria can be estimated with a good degree of confidence. At the other extreme are projects that have been minimally explored, for which criteria values can only be assumed, based on averages at other fields in similar settings. (see Appendix III and Table III-1)

The criteria are:

- Reservoir Temperature
- Reservoir Area
- Reservoir Thickness
- Reservoir Porosity, and
- Resource Recovery Factor

To rigorously consider the uncertainties in these criteria, each is assigned an “error bar” by selecting a most-likely value, together with a minimum value and a maximum value that define an approximately normal probability distribution around the most-likely<sup>6</sup> value.

The minimum, most-likely and maximum values of each criterion are then used in probabilistic simulation (based on Monte Carlo random-number sampling) to calculate estimated generation capacity based on the accessible heat in place at the resource area. Results are expressed in terms of MW capacity for 30 years. Because a probabilistic method of calculation is used, the results can be expressed in terms of a Minimum result (90% cumulative probability), Most-likely (modal) result, Mean result, and the standard deviation of the Mean.

It must be emphasized that the generation capacity estimate is based on calculated heat in place. This does not guarantee that a given resource in which there has been little or no drilling will have the reservoir permeability required to allow commercial production of hot water or steam to a power plant. That can be established only by drilling and testing the production zone.

#### **Exploration Costs (See Section 3.4 And Appendices IV And V)**

Once the generation capacity of an incompletely explored resource area is estimated, this is used in combination with the available set of exploration data to estimate the costs of further exploration (total and per kW). Standard costs for a number of exploration methods have been assumed, based on experience elsewhere, and a work program has been assigned. The exploration programs assigned herein are not necessarily the programs that will be chosen by developers, but are considered reasonable estimates of the total likely costs.

#### **Drilling Costs (See Section 3.3)**

Beyond exploration, the costs of resource confirmation and development depend greatly upon the costs of drilling deep wells. For Project 1.3, drilling costs have been estimated using statistical correlations of drilling cost versus depth, and well productivity versus temperature.

#### **Confirmation Costs (See Section 3.4 And Appendices IV And V)**

Confirmation is the process of drilling and proving enough resource at the wellhead to satisfy the requirements of a lending institution for funding development. For this study, it is assumed that 25% of the desired development capacity must be proven, and the cost of this is calculated using the statistical correlations of drilling cost versus depth and productivity versus temperature, plus certain standard assumptions regarding further costs such as administration, well tests and environmental compliance. A confirmation estimate is made for both the Minimum and the Most-likely estimated generation capacity.

### **Development Costs (See Section 3.5 And Appendices V And VI)**

Development costs cover the process of drilling and proving the remaining amount of the estimated resource capacity, constructing power production facilities, and constructing the transmission line. The drilling costs are estimated by an amplification of the method used for confirmation costs. Power plant and other facilities costs are based on a standard value per kW, derived from information in a variety of published sources. Transmission-line costs have been estimated using input from another contractor to the Hetch Hetchy/SFPUC Programmatic Renewable Energy Project (Electranix Corporation). Development costs are estimated for both the Minimum and the Most-likely estimated generation capacity.

### **Operational Constraints**

Each resource area has certain associated operational constraints, which can be difficult to quantify. These are typically associated with fluids chemistry (*e.g.*, scaling, corrosion, non-condensable gas management), terrain, access, and other institutional or infrastructure factors. A list of notable operational constraints that may occur in each area is included in the PIER Geothermal Database, to assist a qualitative assessment of how operational constraints may be mitigated and how they may affect exploration, confirmation and development costs.

## **2.4. Resource Sites and Geographic Areas**

### **Sites**

Table 1 is a list of all geothermal resource projects in the PIER Geothermal Database. In the usage of this report, a “project” is loosely defined to mean either a single resource area (site), or a subdivision of a resource area. If a given resource area has subdivisions, there is also a “project” that is a “field-wide summary” of the set.<sup>7</sup>

Most subdivisions have historically been geographic; *i.e.*, they represent separate parts of a geothermal anomaly (separate leaseholds) that were explored, confirmed or developed at different times, sometimes by different developers. Over time, many of these subdivisions have been consolidated under the control of a single developer or operator, and in some cases there are even pipelines that now interconnect the wells in different subdivisions.

The actual portfolio of real and potential development projects, in terms of estimated generation capacities and costs, comprises single resource areas and field-wide summaries of subdivided resource areas. This subset of the entire database is indicated in Table 1 by a check box under the heading “Gen(eration) Cap(acity) Estimated”.

### **Geographic Areas**

At the start of Project 1.3, the geothermal resource sites in the subject area (section 2.2) were divided into two geographic areas. Area 1 comprised a corridor of 50 miles on either side of the HVDC intertie (including resource sites in both California and Nevada, and later expanded to include all of Nevada as far east as Beowawe). Area 2 comprised the remaining portions of California more than 50 miles from the HVDC intertie. Areas 1 and 2 were referred to as the HVDC and non-HVDC areas, respectively.

It subsequently developed that the broader Hetch Hetchy/SFPUC Programmatic Renewable Energy Project could more conveniently use a different geographic breakdown, and this final report now uses the following:

Area 1 – Greater Reno, Nevada (including nearby California sites at Honey Lake)

Area 2 – Nevada sites with direct access to the California grid

Area 3 – Other Nevada locations

Area 4 –All California locations (excluding Honey Lake)

An example of Area 2 is Dixie Valley, Nevada, which sends power to Southern California Edison via a transmission line that extends south into California. Other locations along or close to this route are included in Area 2, which is also referred to in this report as the Dixie Corridor.

## **2.5. Task List**

The formal Task List of separate defined activities and deliverables for Project 1.3 has been:

|             |  |
|-------------|--|
| Task 1.3.1  | Acquire and assess resource data for Area 1                          |
| Task 1.3.2  | Estimate generating potential for Area 1                             |
| Task 1.3.3  | Develop statistical correlations required to estimate drilling costs |
| Task 1.3.4  | Estimate exploration and resource confirmation costs for Area 1      |
| Task 1.3.5  | Estimate development costs for Area 1                                |
| Task 1.3.6  | Acquire and assess resource data for Area 2                          |
| Task 1.3.7  | Estimate generating potential for Area 2                             |
| Task 1.3.8  | Estimate exploration and resource confirmation costs for Area 2      |
| Task 1.3.9  | Estimate development costs for Area 2                                |
| Task 1.3.10 | Final Project Report   |

(Areas 1 and 2 of this list refer to the HVDC and non-HVDC areas as originally defined. In this report, Areas 1 and 2 have been superseded by Areas 1 to 4, as described in section 2.4.)

Some of these Tasks have been carried out sequentially, while others have been carried out simultaneously. All of Tasks 1.3.1 – 1.3.9 have been subject to continuous revision and update during the course of the project, to enable refinement of the database and the final product, which is represented by this report.

## **2.6. PIER Geothermal Database (MS Access©)**

### **2.6.1. General Description and Organization of the Data**

The PIER Geothermal Database contained on the CD attached to this report is a compilation of geothermal data and information developed to meet the objectives Project 1.3. It has evolved as work on Project 1.3 has progressed. The database on the attached CD synthesizes and replaces all previous versions of the database.

The database is not (and is not intended to be) comprehensive, either with respect to all possible geothermal projects, or with respect to all available data and information. Rather, it is intended to provide:

1. A portfolio of reasonably well-characterized geothermal resources that are located within the subject geographic area;
2. A brief overview of each resource area with respect to exploration and development history, well drilling and well characteristics, and the physical and chemical characteristics of the resource; and,
3. At least the minimum amount of information needed to:
  - a. Characterize each resource in terms of minimum and most-likely generating capacity;
  - b. Estimate the costs of exploration and development that will be required to reach those capacities, if not already met; and,
  - c. Calculate the associated total development costs and unit development cost.

The information in the database has been obtained from the sources described in section 2.1. Citations to significant sources of published information are included, but there has been no attempt to make the citations or the bibliography all-inclusive. Proprietary sources (data released for this project) are acknowledged. GeothermEx has endeavored to make the database as free of errors and mis-information as is possible, but cannot be responsible for errors and omissions in either published or previously proprietary sources of data that have been used.

The database includes a combination of numeric data and text, embedded figures, and reports in tabular and narrative format. This information is contained in a set of data tables that are linked in relational format by the unique project ID number (5-character code) that identifies each project, and by ID codes that identify each separate reference.

The user interface of the database includes three principal windows: the Startup window (Figure 2), the Projects window (Figure 3), and a Reports and Documents window (Figure 4). All of the data, figures, and reports are available via command buttons that open other windows dedicated to subsets of the data, or that preview the reports or figures on-screen so that they may be sent to a printer.

## Hetch Hetchy / SFPUC Programmatic Renewable Energy Project

**Project:** 1.3 New Geothermal Site Identification and Qualification  
**Project Team:** GeothermEx, Inc.  
**Task:** 1.3.10 Final Project Report  
**Subject:** D.1.3.10.3: Final Report

Date: 31 Dec. 2003

GeothermEx Database  
v.031231

View Projects Data and Figures

Preview and Print Reports and Documents

Description of Database

How to Use the Database

Close

HHWP-042, D1.3.10.3, 31 December 2003
500-01-042

Figure 2 Startup window for PIER Geothermal Database in MS Access®

PIER Geothermal Database - [PROJECTS]

File Edit View Insert Format Records Tools Window Help

Choose Project: Cosco 7

### Hetch Hetchy/SFPUC Programmatic Renewable Energy Project Project 1.3: Geothermal Project Areas

**PROJID:** COS00 Edit/Lock

**Area:** 4 Get-up data

**Name: District/Area/Field:** Cosco

**Name: Area/Power Plant:** Field-wide Summary

**State:** CA **County:** Inyo

**KGPA:** Cosco Hot Springs

**Lat(N):** 36.83° **Long(W):** 117.80°

**Owner:** Calhoun Energy LLC

**Developer:** California Energy Company, Inc.

**Financier:**

**Operator:** Cosco Operating Company LLC

**MW installed:** 300 -gr 270 -net

**MW produced (yr):** 275 (2002)

**Plant Technology:** Dual Flash

**Start Date Yr:** 1967 (Nevyl)

**Exploration-Development Category:** A

**Generation Capacity Estimated?** Y

**Notes: Project**

Nine turbine-generator units at four plant sites in three project areas: Nevyl I (COS01), Nevyl II (COS02) and BLMI (COS03). Power is sold to Southern California Edison. All project areas are within the China Lake Naval Air Weapons Station. MW installed values are listed separately for each project. Fieldwide total is 300 MW-gross and 270 MW-net. The MW produced in 2002 is based on data in Figure COS00-3.

**CURRENT PROJECT DATA SCREENS**

Contacts

Reservoir Physical Properties

Generation Capacity

Land

Reservoir Chemical Properties

Exploration Program

Explor-Dev History

References

Confirmation Costs - Min

Government Funding

Figures

Confirmation Costs - Mid

Well Summaries

Development Costs - Min

Operational Constraints

Development Costs - Mid

**CURRENT PROJECT DATA REPORTS**

Data Summary

Expl - Conf - Dev Programs & Costs

Figure List

References

**OTHER SCREENS & REPORTS**

Location map (Fig.1) ?

Project References by Author

All Other References (Gen. Citations)

Abbreviations & Definitions

Multi-Project Reports & Documents

Query Main Facts ?

Description of Database

How to use the database

Close

HHWP-042 D1.3.10.3, 31 December 2003
500-01-042

Record: 19 of 155

Form View

Figure 3 "PROJECTS" window (example) from the PIER Geothermal Database in MS Access®

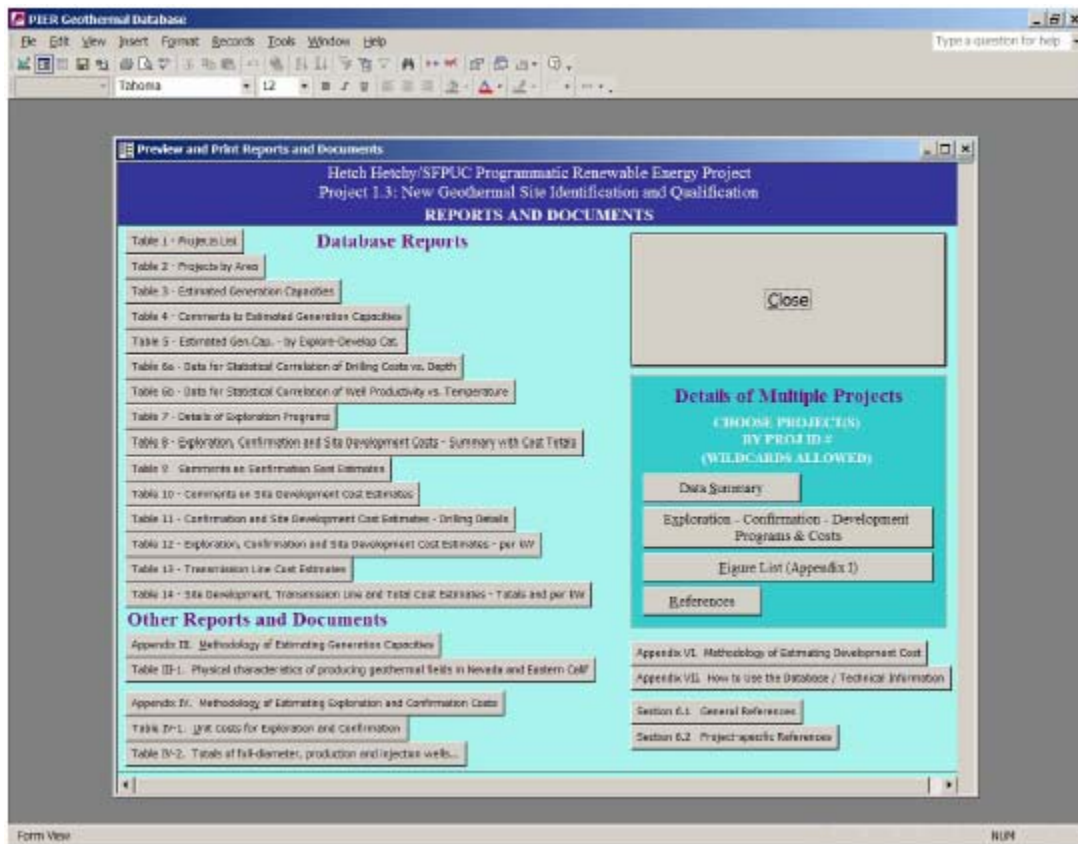


Figure 4 “REPORTS AND DOCUMENTS” window from the PIER Geothermal Database in MS Access©

### 2.6.2. Instructions for Use

Instructions for using the database, including the printing of reports or figures, are contained in Appendix VII.



## Project Outcomes

### **2.7. Resource Data**

#### **2.7.1. Methodology**

In a manner consistent with the goals and objectives of Project 1.3, geothermal resource data have been compiled using published sources, information from GeothermEx's files of non-proprietary resource information, and responses from developers who chose to assist the process of data acquisition for this study.

The data of principal interest have been: resource size (depth, area, and thickness), temperature, fluids chemistry, well productivity, and operational constraints (corrosion, scaling, access, terrain, and possible usage restrictions such as wetlands). These data have been used to prepare the PIER Geothermal Database (in MS Access©) that is included on the CD attached to this report and described in section 2.6 and Appendix VII.

#### **2.7.2. Results**

The PIER Geothermal Database contains information on 155 separate geothermal projects in the states of California and Nevada, which represent a total of 83 different resource areas. Six of the 83 areas are represented by name only, because they were found listed by others as having some degree of interest for geothermal exploration, but little to no further information could be found, or they did not meet all of the resource criteria that are outlined in section 2.2. Of the 77 remaining resource areas, 58 have been selected for estimation of generation capacity (section 3.2); others did not meet all of the criteria of section 2.2.

Table 1 contains a list of all projects, with basic identification, location, exploration-development category (see this section, below) and an indication of whether generation capacity has been estimated. The separate resource areas are those with an ID number that ends in 00 (see section 2.4).

Table 2 is the same list, organized by the geographic areas described in section 2.4.

Figure 1 shows the locations of the resource areas for which generation capacity has been estimated (section 3.2).

Chapter 6 contains a list of all references cited in the database (also available within the database, as a report).

Chapter 7 contains a list of data abbreviations used in the database (also available within the database).

Appendix I is a list of all figures in the database, organized by project (also available within the database, as a report).

Appendix II is an example of a "Project Data Summary Report", which contains all of the database information for a project, except for the figures associated with it as Adobe Acrobat© (\*.pdf) files embedded in the database.

Nearly all resource areas in the project are illustrated by a local site area map, of which Figure 5 is an example. These contain topography, roads, power lines, lease boundaries (where available), hot springs, locations and depths of wells, temperature gradients and bottom-hole temperatures, and (as possible) the outlines of temperature anomalies.

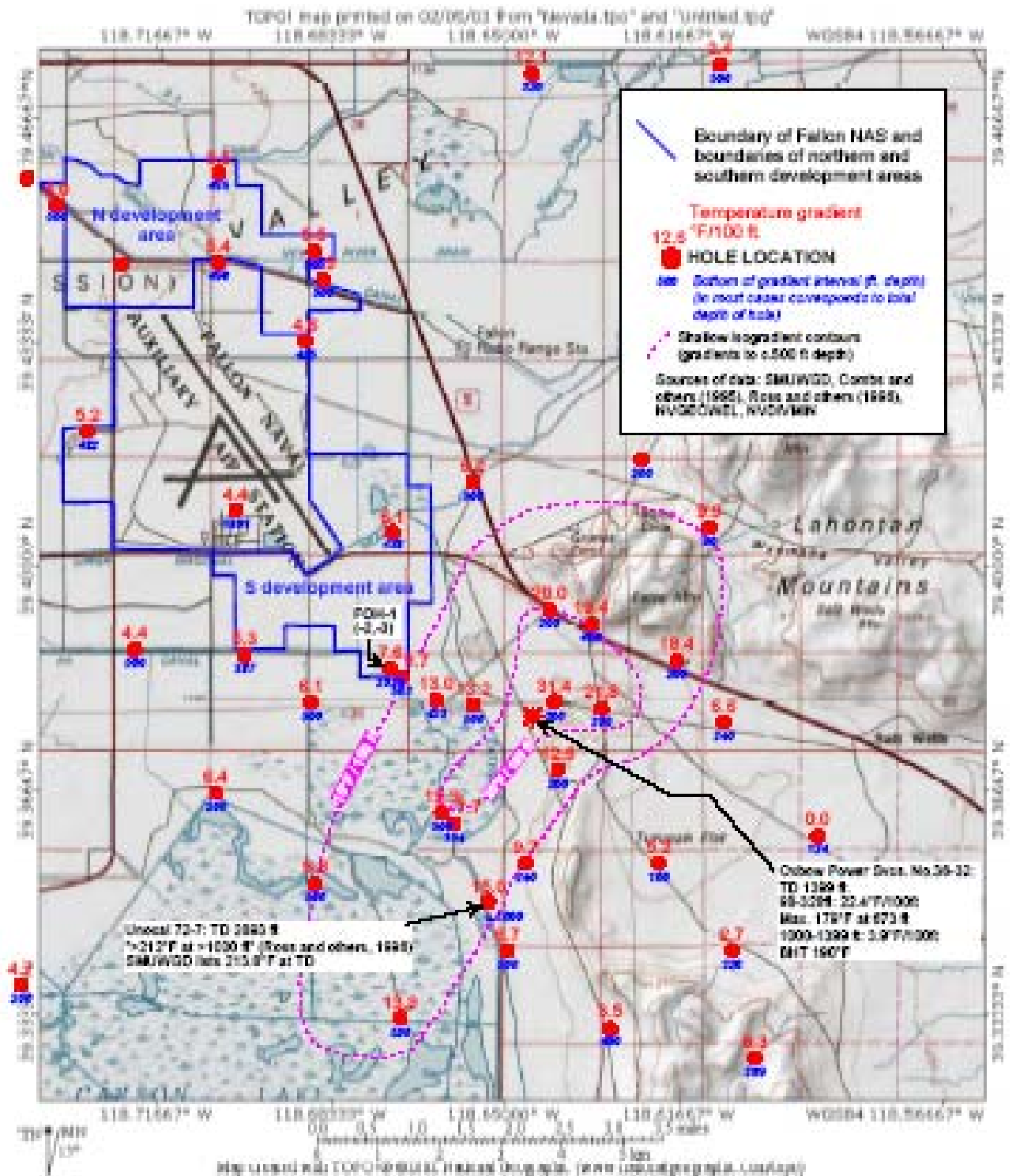


Figure 5 Local Site Area Map (Example)

Where possible, each resource area is also illustrated by a downhole temperature graph, which illustrates or summarizes the available information from temperature gradient and/or deep drill holes. Figure 6 is an example.

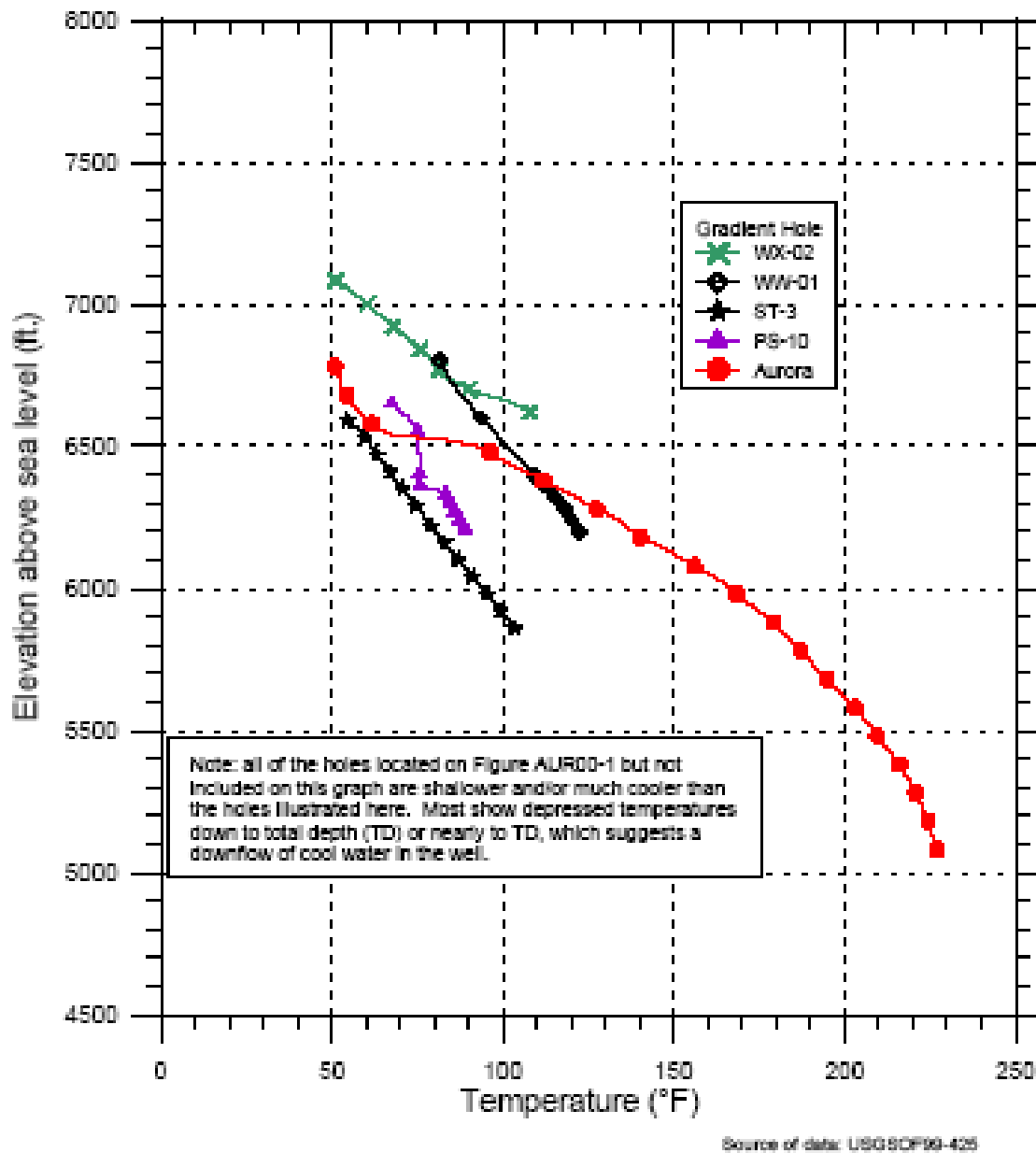


Figure 6 Local Site Downhole Temperature Graph (Example)

Many areas are also illustrated by additional figures, as listed in Appendix I.

### Exploration - Development Category

The amounts of information for a given resource area vary widely, from quite complete, to very limited, depending on whether the resource has been explored, confirmed or developed, and how much information has been released. To assist a quick evaluation of the status of a project and how confidently it can be characterized, each has been assigned to a development category, as follows:

- A – Existing Power Plant Operating (16 of 83 resource areas)
- B – One or more wells tested with a potential greater than or equal to ( $\geq$ ) 1 MW, but no power plant in operation (7 of 83 resource areas)
- C – Minimum 212°F logged downhole, but no well tests at  $\geq$  1 MW (29 of 83 resource areas)
- D – Other exploration data and information available ( $\geq$ 212°F not proven) (25 of 83 resource areas)
- No category assigned – In cases of areas not meeting the criteria of section 2.2 (6 of 83 resource areas).

This information is not sufficient to rank the attractiveness of any individual project, especially in categories B and C, but it does assist the process.

## **2.8. Generating Potential**

### **2.8.1. Methodology**

As described briefly in section 2.3, generation capacities of the resource areas have been estimated using a probabilistic (Monte Carlo) method applied to a calculation of heat in place. The resource parameters used for each calculation are listed and annotated in the database under Reservoir Physical Properties, and results are listed and annotated under Generation Capacity (see Figure 3). The theoretical basis for the calculation of generation capacities and the rationale for assigning resource parameters are described in Appendix III.

Appendix III includes Table III-1, which presents a summary of reservoir characteristics at 11 well-characterized, producing geothermal fields in Nevada and eastern California. As explained in Appendix III, the averages of these characteristics have been used, on a case-by-case basis, to assign default values to the unconfirmed characteristics of resource areas which remain inadequately explored and drilled.

### **2.8.2. Results**

Estimated generation capacities of 58 resource areas, grouped by geographic areas, are listed in Table 3. Several of the resource areas have subdivisions with separate capacity estimates, such that the total number of capacity estimates listed is 65. Comments associated with each capacity estimate are presented in Table 4. Table 5 presents the generation capacities listed by Exploration-Development Category. Each calculation of generation capacity (with associated input parameters) produces a tabular and graphical summary of the results, of which Figure 7 is an example.

#### SUMMARY OF INPUT PARAMETERS

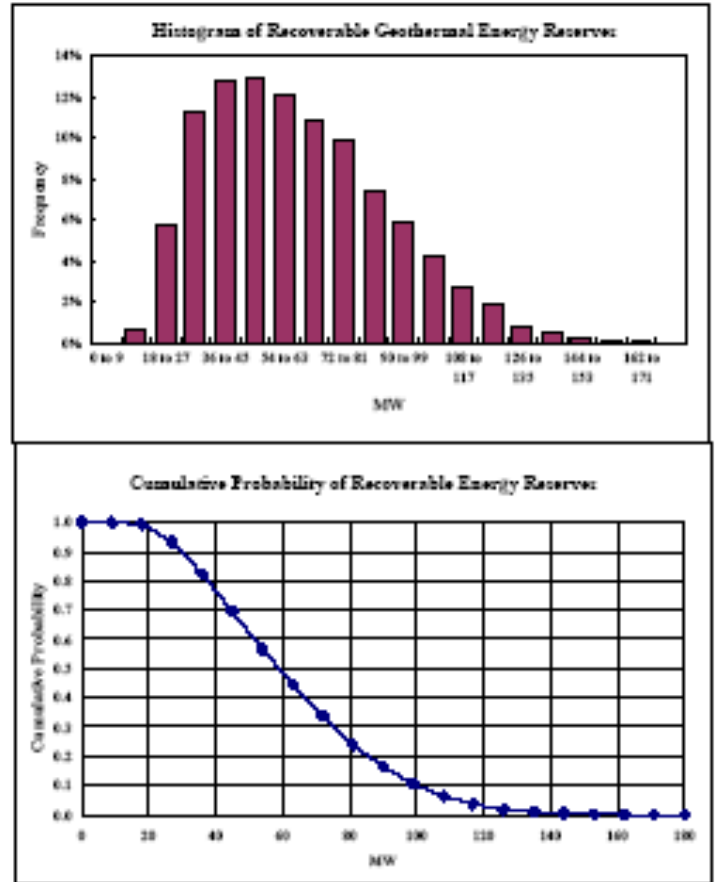
| Variable Parameters        | Minimum | Most Likely | Maximum |
|----------------------------|---------|-------------|---------|
| Reservoir Area (sq. mi.)   | 1.7     | 3.4         | 5.1     |
| Reservoir Thickness (ft)   | 2500    | 3500        | 4500    |
| Rock Porosity              | 0.03    |             | 0.07    |
| Reservoir Temperature (°F) | 340     |             | 380     |
| Recovery Factor            | 0.05    |             | 0.10    |

| Fluid Parameters              |      |              |
|-------------------------------|------|--------------|
| Rock Volumetric Heat Capacity | 39.0 | BTU/deg. ft³ |
| Rejection Temperature         | 50   | °F           |
| Utilization Factor            | 0.45 |              |
| Plant Capacity Factor         | 0.90 |              |
| Power Plant Life              | 30   | years        |

#### RESULTS

|                     | Statistics |            |                     |
|---------------------|------------|------------|---------------------|
|                     | MW         | MW/sq. mi. | Recovery Efficiency |
| Mean                | 62.40      | 18.35      | 1.25%               |
| Std. Deviation      | 26.82      | 8.86       | 0.43%               |
| Minimum (90% prob.) | 36.14      | 9.43       | 0.64%               |
| Most-Likely (Modal) | 46.95      | 12.90      | 0.83%               |

**Figure FI500-2:**  
Probabilistic Calculation of Geothermal Energy Reserves  
FISH LAKE VALLEY, NEVADA



**Figure 7 Probabilistic Calculation Of Geothermal Energy Reserves (Example)**

Individual estimates range from as small as a minimum (Min) value of 3.6 MW (Sespe Hot Springs, California) to as large as a most-likely (Mlk) value of 1,750 MW (Salton Sea, California). The totals by area (Table 3) and by state are:

| Area |                                    | Installed MW<br>(2003) |       |                         | <u>Estimated Total Generation Capacity</u><br>(MW - 30 years) |                            |       |                         |
|------|------------------------------------|------------------------|-------|-------------------------|---|----------------------------|-------|-------------------------|
|      |                                    | Gross                  | Net   | Net /<br>Gross<br>Ratio | Min<br>(90%<br>prob.)   | Most-<br>likely<br>(modal) | Mean  | Std.<br>Dev. of<br>Mean |
| 1    | Greater Reno (NV + Honey Lake, CA) | 184                    | 139   | .75                     | 552   | 787                        | 1,169 | 129                     |
| 2    | NV with direct access to CA        | 66                     | 56    | .85                     | 363   | 572                        | 780   | 136                     |
| 3    | Other NV                           | 0                      | 0     | -                       | 91  | 141                        | 220   | 51                      |
| 4    | CA excluding Honey Lake            | 1,863                  | 1,661 | .89                     | 3,638   | 4,723                      | 5,321 | 480                     |
|      | All California                     | 1,869                  | 1,664 | .89                     | 3,644   | 4,731                      | 5,334 | 480                     |
|      | All Nevada                         | 244                    | 192   | .79                     | 1,000   | 1,492                      | 2,156 | 194                     |
|      | TOTALS                             | 2,113                  | 1,856 | .88                     | 4,644   | 6,223                      | 7,490 | 518                     |

The incremental totals (Estimated New Gross Power Plant Capacity, calculated as Estimated Total Generation Capacity minus Installed Gross MW) are:

| Area |                                    | Installed<br>Gross MW<br>(2003) | <u>Estimated New Gross Power Plant<br/>Capacity</u><br>(MW - 30 years) |                        |
|------|------------------------------------|---------------------------------|--|------------------------|
|      |                                    |                                 | Minimum<br>(90% probability)   | Most-likely<br>(modal) |
| 1    | Greater Reno (NV + Honey Lake, CA) | 184                             | 368  | 603                    |
| 2    | NV with direct access to CA        | 66                              | 297  | 506                    |
| 3    | Other NV                           | 0                               | 91   | 141                    |
| 4    | CA excluding Honey Lake            | 1,863                           | 1,775  | 2,860                  |
|      | All California                     | 1,869                           | 1,775  | 2,862                  |
|      | All Nevada                         | 244                             | 756  | 1,248                  |
|      | TOTALS                             | 2,113                           | 2,531  | 4,110                  |

Public records that list the installed gross and net capacities of existing installations do not always agree in detail, so the total capacities in these tabulations are uncertain by a few percent. The ratios of net to gross have corresponding uncertainties, but it is probable that the relatively low net/gross ratio in Area 1 reflects a dominance of binary power plants with pumped wells, and the high net/gross ratio in Area 4 reflects dominance of The Geysers, Coso and Salton Sea fields, where wells are not pumped.

If it is assumed that the future new power installations in Areas 1, 2 and 4 will have the same average net/gross ratios as existing plants, and that Area 3 (likely all binary) will have the same net/gross ratio as Area 1, then the estimated new net power plant capacities, by resource area and by state, are:

| Area |                                    | <u>Estimated New Net Power Plant Capacity</u><br>(MW – 30 years) |                        |
|------|------------------------------------|--|------------------------|
|      |                                    | Minimum<br>(90% probability)                                     | Most-likely<br>(modal) |
| 1    | Greater Reno (NV + Honey Lake, CA) | 276  | 452                    |
| 2    | NV with direct access to CA        | 252  | 430                    |
| 3    | Other NV                           | 68   | 106                    |
| 4    | CA excluding Honey Lake            | 1,580  | 2,545                  |
|      | All California                     | 1,580  | 2,547                  |
|      | All Nevada                         | 596  | 986                    |
|      | TOTALS                             | 2,176  | 3,533                  |

The estimates of new gross and new net power capacity in the previous two tables are based on the simple difference between estimated total resource capacity and nominal installed power plant capacity. In sections 3.4 and 3.5, these figures are refined by: (a) considering actual generation (cases of under-utilized plant capacity), (b) considering unused but available wellhead capacity (cases of un-used wells), and (c) excluding a few projects for which confirmation and development costs are not estimated (for reasons given in the PIER Geothermal Database).

## 2.9. Statistical Correlations For Drilling Costs

Two statistical correlations have been developed to estimate drilling costs in geothermal development for the purposes of this study:

1. Drilling Costs Vs. Depth
2. Well Productivity Vs. Temperature

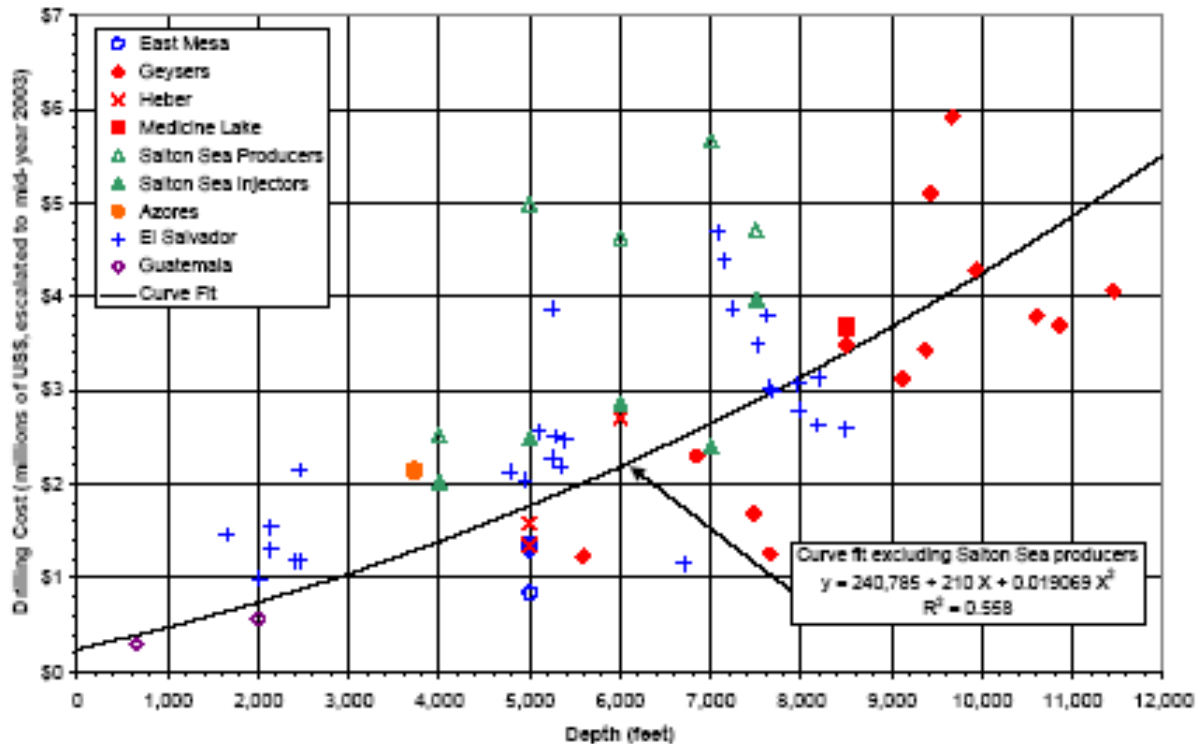
These correlations are expressed graphically in Figures 8 and 9. The statistical data underlying the correlations are included in Tables 6a and 6b.

### 2.9.1. Drilling Costs Versus Depth

The correlation of drilling costs vs. depth (Figure 8) is based on data from 182 wells in eight fields. We have relied on two primary sources for geothermal drilling costs within the United States:

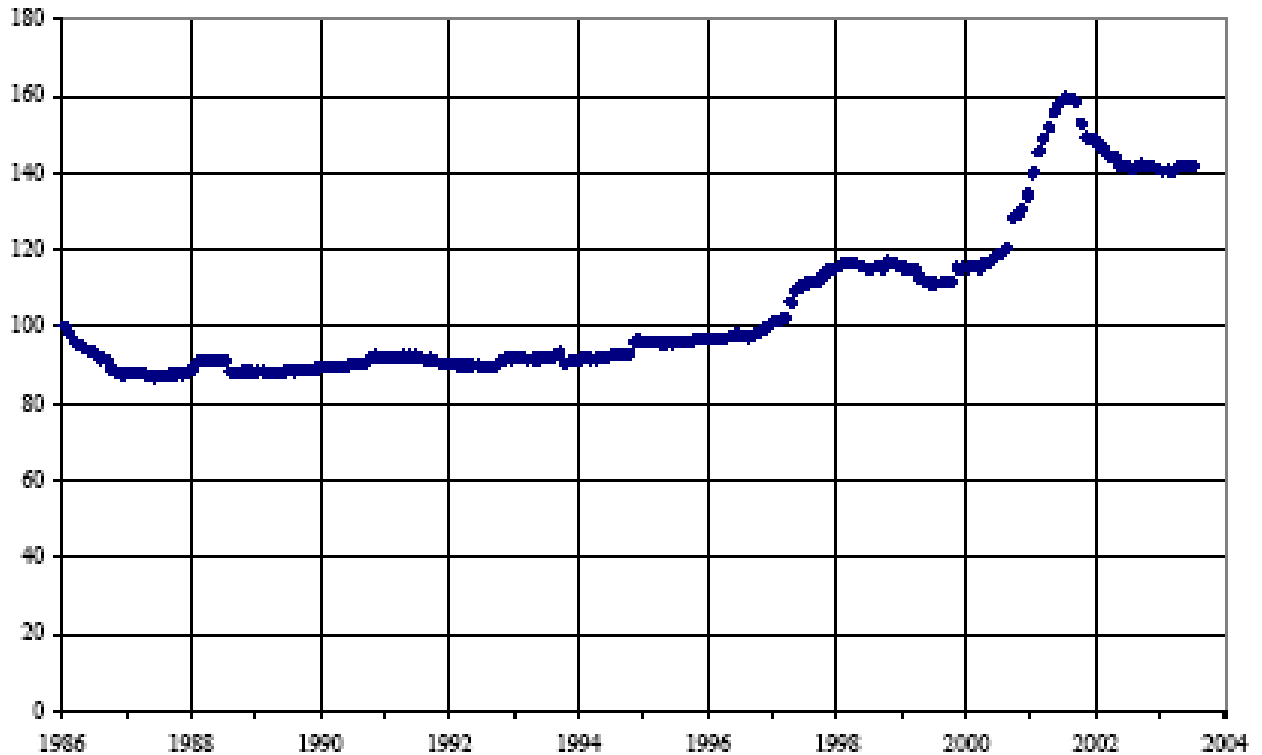
- A database of Geysers wells drilled between 1985 and 1995, provided with the cooperation of Calpine Corporation and Sandia National Laboratory.
- A database of wells drilled between 1985 and 1993 in the East Mesa, Heber, and Salton Sea fields, provided by the California Energy Commission (CEC) from the Geothermal Cost Survey (GCS) conducted in 1993. The GCS information had a

confidentiality window of 10 years and is now in the public domain. The CEC also made available drilling cost data for a well at Medicine Lake (88A-28) that Calpine drilled in 2002 with partial CEC funding.



**Figure 8 Correlation Of Drilling Cost Vs. Well Depth**

Because of proprietary concerns of several geothermal operators and the relatively small amount of recent geothermal drilling within the United States, we have also incorporated data from representative geothermal wells completed between 1997 and 2000 in Central America and the Azores. To account for inflation, the costs of all wells have been escalated to equivalent US dollars as of 1 July 2003, using the Producer Price Index (PPI) for onshore oil and gas drilling from the US Department of Labor, Bureau of Labor Statistics, Series PCU1381#9 (N). Figure 9 shows a plot of the monthly PPI factors used for this escalation. Table 6a shows the completion date, depth, cost, and escalation factor for each well used in the correlation. The table does not show actual well names, but the wells are listed by field with an assigned sequence number (for instance, Geysers 1 to Geysers 13).



**Figure 9 Correlation of Well Productivity Vs. Production-Zone Temperature**

The wells used in the correlation have included a mix of production and injection wells. Wellbore diameters within the reservoir were generally 12-1/4-inch or 8-1/2-inch. Slim holes and temperature gradient holes were not included in the data set. For wells with multiple legs (forked completions), an attempt was made to consider just the cost of the first leg. Where segregating the cost of the first leg was not possible, the deepest leg was used to correlate with the total well cost. An attempt was also made to include pad construction costs and the costs of mobilization and de-mobilization (mob and de-mob) of the drilling rig. However, pad construction costs may not be included if a well was drilled from an existing pad. Mob and de-mob costs can vary widely, depending on the terms negotiated with the rig contractor and the distance from previous and subsequent wells. These factors, as well as the variability of the geologic formations drilled, lead to considerable scatter in the data set.

Despite the scatter, there is a rough correlation between drilling cost and well depth, as Figure 8 illustrates. In this figure, GCS data points actually represent average values for several wells, because well costs reported in the GCS data sheets were aggregated by project. Figure 8 includes a curve fit to the data set using a second-order polynomial. The GCS data points have been weighted based on the number of wells in the average for each point. The curve fit includes all wells in the data set except for 32 production wells in the Salton Sea field (represented by five points in Figure 8 from averaged GCS data). These Salton Sea producers are above the general cost trend, probably because the GCS averages include some wells with above-average diameters and non-standard metallurgy (such as titanium casing). Salton Sea injection wells plot within the band of

data scatter, and they have been included in the curve-fit calculation. The formula for the curve fit is:

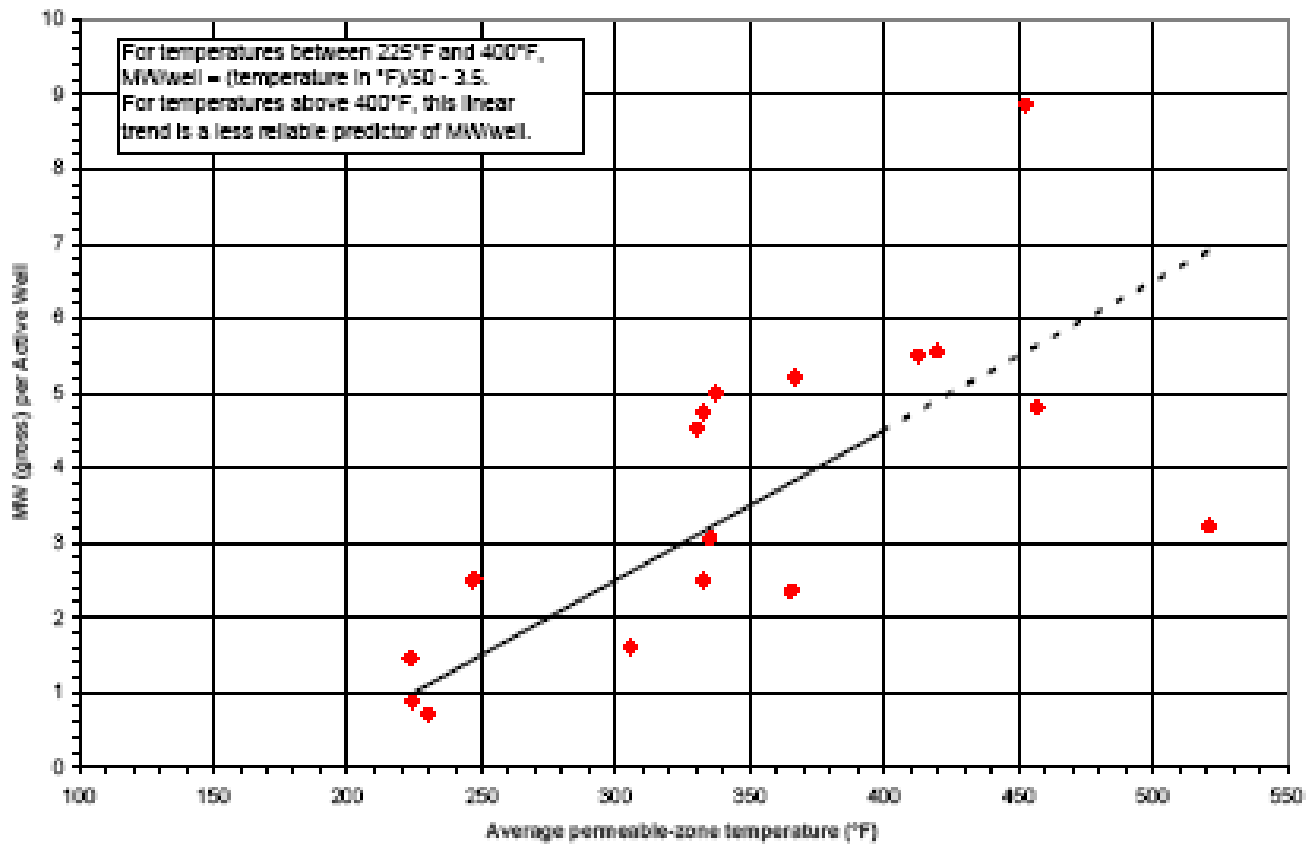
$$\text{Drilling cost (in US\$)} = 240,785 + 210 \times (\text{depth in feet}) + 0.019069 \times (\text{depth in feet})^2$$

The quality of the curve fit can be expressed as the square of the sample correlation coefficient ( $r^2$  or R-squared). R-squared can range from 0 to 1, and values closer to 1 indicate a higher degree of correlation. The R-squared value for the curve fit is 0.558, which indicates that 55.8% of the variance in drilling cost is accounted for by depth.

### **2.9.2. Well Productivity Versus Temperature**

The correlation of well productivity vs. temperature was estimated based on 17 fields with sufficient data to be considered (Table 6b). For each field, the productivity per well was estimated by dividing the plant capacity (gross megawatts) by the number of active production wells. This value was correlated with the average temperature of the main permeable zone in the reservoir.

As shown in Figure 10, there is a roughly linear correlation between well productivity and temperature for geothermal resources below about 400°F. In this temperature range, geothermal production wells are often pumped, and the productivity of wells is strongly affected by pump capacity over a narrow range of well diameters. Above about 400°F, commercial resources are generally self-flowing, and the productivity of individual wells is strongly affected by the permeability of the formation, which can vary widely.



**Figure 10 Producer Price Index for Drilling Oil and Gas Wells (Onshore Drilling)**

An additional factor leading to scatter in the correlation is the fact that well productivities are calculated for all active producers, including wells that may have declined significantly from their initial potentials. For instance, the right-most data point in Figure 10 comes from the Coso field, which calculates an average productivity of just 3.2 MW (gross) despite a permeable-zone temperature averaging above 520°F. If initial potentials were used for Coso wells, the average productivity would be much higher. Conversely, the highest point in Figure 10 comes from Dixie Valley, where declines in productivity have been relatively low.

In addition, a number of reservoirs have high temperatures that do not correlate at all with high well productivity; these are candidates for development by enhanced geothermal system (EGS) techniques. Thus, in planning the number of wells required for a new geothermal development or expansion of an existing field, the use of a correlation based strictly on temperature is of limited utility, especially for higher-temperature fields. Resource-specific information from well testing must be taken into account whenever possible.

## **2.10. Exploration and Resource Confirmation Costs**

### **2.10.1. Methodology**

In the context of Project 1.3, the exploration of a resource consists of geotechnical activity up to and including the point of siting a first, deep, commercial-diameter hole. The exploration costs of a project are estimated by assigning a likely program of activities, and applying to this program a set of assumptions and standard costs that are described in Appendix IV and in Table IV-1, with cost adjustments applied for specific cases.

The two most expensive exploration activities considered herein are drilling intermediate-depth (ID) slim holes (usually to at least 2,000 ft), and magneto-telluric (MT) or direct-current (DC) resistivity surveys. One or more ID slim holes are almost always included if no holes to similar depths have already been drilled. Resistivity surveys are included only rarely, because it has been our experience that these surveys have had limited success in yielding drilling targets at medium-temperature, non-volcanic geothermal systems.

Confirmation consists of doing enough deep drilling, well testing and reservoir testing to confirm at the wellhead 25% of estimated generation capacity. This is the approximate percentage that is likely to be required by a lending institution for funding development. Some injection capacity is also required, to dispose of the fluids from production tests, but drilling of dedicated injection wells is not included in the confirmation estimates. Instead, it is assumed that test fluids can be injected into other production wells (successful or unsuccessful) or existing ID slim holes. At a few very small projects, where one confirmation well might suffice, the number is adjusted to two, so that injection capacity will be available.

If a resource is already being produced, then confirmation is the process of proving 25% of the difference between the total estimated capacity and capacity already being exploited. If there are idle but proven production wells, then the capacities of these wells are subtracted from the 25% requirement before the confirmation program is estimated.

As with exploration, confirmation is estimated using a set of assumptions and standard costs. The cost of deep drilling is a function of: (a) reservoir depth, (b) typical drilling cost per foot (described in section 3.3), (c) expected well productivity as a function of resource temperature (also in section 3.3), (d) the total MW that must be proven, and (e) an assumed percentage of unsuccessful holes compared to total holes drilled. To the drilling cost are added such additional costs as well and reservoir testing, reporting and administration. Complete details of the confirmation method, unit costs and background information are contained in Appendix IV and in Tables IV-1 and IV-2.

### **2.10.2. Results**

The details of the exploration programs are contained in Table 7, and the combined detail of exploration, confirmation and development at any individual project can be obtained as a report in the PIER Geothermal Database (use the “Expl-Conf-Dev Programs & Costs” button at the bottom of the Projects window, Figure 3). (Development costs are discussed in section 3.5.) Total exploration costs, confirmation

costs, and development costs are listed in Table 8 (summary with cost totals), Table 11 (drilling details), and Table 12 (costs per kW). Comments on the confirmation costs for each separate project are contained in Table 9.

For each geographic area, the total exploration and confirmation costs (from Table 8) and total new gross MW being developed (from Table 12) are as follows:

| Area |  | Exploration<br>Costs<br>(thousands<br>) | <u>Confirmation</u>                         |   |   |   |
|------|--|---|---|---|---|---|
|      |  |   | New Gross<br>MW being<br>developed<br>(Min) | Confir-<br>mation<br>Costs<br>(thousands) | New Gross<br>MW being<br>developed<br>(Most-<br>likely) | Confir-<br>mation<br>Costs<br>(thousands<br>) |
| 1    | Greater Reno<br>(NV + Honey<br>Lake, CA) | \$8,684                                 | 419   | \$142,255                                 | 643   | \$213,154                                     |
| 2    | NV with direct<br>access to CA           | \$4,056                                 | 297   | \$115,896                                 | 506   | \$182,706                                     |
| 3    | Other NV                                 | \$7,968                                 | 91  | \$37,499                                  | 141   | \$58,253                                      |
| 4    | CA excluding<br>Honey Lake               | \$7,077                                 | 1,990                                       | \$609,942                                 | 3,041   | \$984,765                                     |
|      | All California                           | \$7,077                                 | 1,995                                       | \$611,658                                 | 3,048   | \$988,014                                     |
|      | All Nevada                               | \$20,708                                | 802   | \$293,934                                 | 1,283   | \$450,864                                     |
|      | TOTALS                                   | \$27,785                                | 2,797                                       | \$905,592                                 | 4,331   | \$1,438,878                                   |

The totals per kW in each geographic area are as follows (from Table 12; E = Exploration, C = Confirmation):

| Area |                                   | <u>Exploration and Confirmation Costs / kW</u> |       |       |       |           |       |       |       |
|------|-----------------------------------|--|-------|-------|-------|-----------|-------|-------|-------|
|      |                                   | Min<br>MW                                      | \$/kW |       |       | Mlk<br>MW | \$/kW |       |       |
|      |                                   |  | E     | C     | E+C   |           | E     | C     | E+C   |
| 1    | Greater Reno (NV+ Honey Lake, CA) | 419  | \$21  | \$339 | \$360 | 643       | \$14  | \$332 | \$345 |
| 2    | NV with direct access to CA       | 297  | \$14  | \$391 | \$405 | 506       | \$8   | \$361 | \$369 |
| 3    | Other NV                          | 91   | \$88  | \$412 | \$500 | 141       | \$57  | \$413 | \$470 |
| 4    | CA excluding Honey Lake           | 1,990  | \$4   | \$306 | \$310 | 3,041     | \$2   | \$324 | \$326 |
|      | All California                    | 1,995  | \$4   | \$307 | \$310 | 3,048     | \$2   | \$324 | \$326 |
|      | All Nevada                        | 802  | \$26  | \$366 | \$392 | 1,283     | \$16  | \$351 | \$367 |
|      | TOTALS/ Averages                  | 2,797  | \$10  | \$322 | \$332 | 4,331     | \$6   | \$331 | \$338 |

Note that the values of new gross MW listed here differ somewhat from the estimates of new gross power plant capacity in Section 3.2.2. The values listed here (and in Table 12) take into account both underutilized plant capacity and productive but unused wells. Because projects can be constrained by either insufficient plant capacity or insufficient power at the wellhead, the numbers listed here are more representative of the actual incremental output that would be achieved if the minimum or most-likely estimates of generation capacity were fully developed.

## 2.11. Development Costs

### 2.11.1. Methodology

For every project with an estimation of generation capacity, development cost is estimated as the sum of three components:

1. Drilling Cost
2. All other On-site Capital Costs, and
3. Transmission-line Cost.

Drilling cost is estimated using a method similar to that applied to confirmation drilling, except that injection wells are included using temperature criteria that distinguish between binary, flash-steam, and dry-steam projects. Another difference in estimating development costs is that there is a more differentiated handling of the drilling success rate, using both the historic averages of a number of projects and the particular drilling histories of individual projects. In addition, the drilling program for the development cost estimate is designed to establish 105% of needed wellhead capacity, which provides a 5% reserve. Complete details of the method are described in Appendix VI.

Other On-site Capital Cost is calculated as the aggregate cost of capital components (all pipelines and pumps, the power plant, pollution abatement, substation and transmission-line connection, roads, legal, regulatory, reporting and documentation, etc.), described simply as the cost of the power plant and gathering system. The value used herein is US\$1,500/kW installed, which is multiplied times the difference between Estimated Generation Capacity in MW (resource capacity) and the lesser of existing plant capacity (if any) or power available at the wellhead, in gross MW. The basis for the aggregate value of \$1,500/kW is described in Appendix VI, which includes a tabulation of various capital cost estimates that have been made by others since 1995 (along with citations). Actual costs of power plants and gathering systems vary over a range based on a number of site-specific factors, including topography and the temperature and chemistry of the resource. Approximate ranges for different plant technologies (estimated based on the references in Appendix VI) are as follows:

| Plant Technology | Capital Cost of Plant and Gathering System (\$/kW installed) |
|------------------|--|
| Dry Steam        | \$1,000 - \$1,500  |
| Single Flash     | \$1,100 - \$1,600  |
| Double Flash     | \$1,200 - \$1,700  |
| Binary           | \$1,400 - \$1,900  |

The value of \$1,500/kW for plant and gathering system falls within the approximate ranges for all plant technologies and has been used across the board for the capital cost estimates in this study.

Transmission-line cost is estimated on the basis of estimates provided by Woodford (2003) (listed in section 6.1 as Woo03a) for the development of a new transmission grid in Area 1 (Greater Reno) that connects to the Pacific Direct-Current Intertie (PDCI), and a connection from the Salton Sea area (Imperial Valley) to the PDCI. The estimates in Woodford (2003) represent 16 specific geothermal projects in northern Nevada. Estimates of the transmission-line costs for other projects are made by applying cost-per-mile data (including substations and taps) from Woodford (2003) to the approximate distance from the project to the nearest point along Woodford's hypothetical expanded grid or an existing transmission line (available capacity for new transmission not confirmed). Complete details of the transmission line cost estimation method are provided in Appendix VI.

#### **2.11.2. Results**

The detailed exploration-confirmation and development program of each individual project can be viewed as a report in the PIER Geothermal Database (use the "Expl-Conf-Dev Programs & Costs" button at the bottom of the Projects window, Figure 3).

Total exploration costs, confirmation costs, and site development costs are listed in Table 8 (summary with cost totals), Table 11 (drilling details), and Table 12 (costs per kW). Comments on the development costs for each separate project are contained in Table 10.

Per geographic area, total on-site development costs (Table 8) and total new MW being developed (from Table 12) are as follows:

| Area |                                       | <u>Site Development (thousands)</u>         |                                   |   |                                   |
|------|---------------------------------------|---|-----------------------------------|---|-----------------------------------|
|      |                                       | New Gross<br>MW being<br>developed<br>(Min) | Site<br>Develop-<br>ment<br>Costs | New Gross<br>MW being<br>developed<br>(Most-likely) | Site<br>Develop-<br>ment<br>Costs |
| 1    | Greater Reno (NV +<br>Honey Lake, CA) | 419   | \$1,196,299                       | 643   | \$1,807,471                       |
| 2    | NV with direct access<br>to CA        | 297   | \$ 898,788                        | 506   | \$1,521,022                       |
| 3    | Other NV                              | 91  | \$ 279,389                        | 141   | \$ 442,601                        |
| 4    | CA excluding<br>Honey Lake            | 1,990                                       | \$4,947,784                       | 3,041   | \$7,695,796                       |
|      | All California                        | 1,995                                       | \$4,958,152                       | 3,048   | \$7,711,606                       |
|      | All Nevada                            | 802   | \$2,364,107                       | 1,283   | \$3,755,284                       |
|      | TOTALS                                | 2,797                                       | \$7,322,259                       | 4,331   | \$11,466,890                      |

The totals per kW of new development in each geographic area for site development (SD) and the combination of exploration + confirmation + site development (E+C+SD) are:

| Area |                                    | <u>Site Development and Exploration+Confirmation+Site Development</u><br><u>Costs / kW</u> |         |         |       |         |         |
|------|------------------------------------|--|---------|---------|-------|---------|---------|
|      |                                    | Min  | SD      | E+C+SD  | Mlk   | SD      | E+C+SD  |
|      |                                    | MW   | \$/kW   | \$/kW   | MW    | \$/kW   | \$/kW   |
| 1    | Greater Reno (NV + Honey Lake, CA) | 419  | \$2,855 | \$3,214 | 643   | \$2,811 | \$3,157 |
| 2    | NV with direct access to CA        | 297  | \$3,026 | \$3,436 | 506   | \$3,006 | \$3,377 |
| 3    | Other NV                           | 91   | \$3,070 | \$3,570 | 141   | \$3,139 | \$3,609 |
| 4    | CA excluding Honey Lake            | 1,990  | \$2,486 | \$2,796 | 3,041 | \$2,531 | \$2,857 |
|      | All California                     | 1,995  | \$2,485 | \$2,795 | 3,048 | \$2,530 | \$2,857 |
|      | All Nevada                         | 802  | \$2,948 | \$3,340 | 1,283 | \$2,927 | \$3,295 |
|      | TOTALS                             | 2,797  | \$2,611 | \$2,944 | 4,331 | \$2,644 | \$2,982 |

Transmission line costs per project are listed in detail in Table 13, and tabulated along with total development costs and total exploration+confirmation+development costs per kW in Table 14. With the transmission line cost estimates included, the development costs per area (total and per kW) are:

| Area |  | <u>Total Development Costs (thousands) and</u> |                           |                                    |           |                           |                                    |
|------|--|--|---------------------------|------------------------------------|-----------|---------------------------|------------------------------------|
|      |  | <u>Total Development Costs / kW</u>            |                           |                                    |           |                           |                                    |
|      |  | Min<br>MW                                      | Total<br>Devel-<br>opment | Total<br>Devel-<br>opment<br>\$/kW | MLk<br>MW | Total<br>Devel-<br>opment | Total<br>Devel-<br>opment<br>\$/kW |
| 1    | Greater Reno<br>(NV+Honey<br>Lake, CA) | 419  | \$1,527,000               | \$ 3,643                           | 643       | \$2,209,000               | \$ 3,437                           |
| 2    | NV with<br>direct access<br>to CA      | 297  | \$1,033,000               | \$ 3,483                           | 506       | \$1,722,000               | \$ 3,405                           |
| 3    | Other NV                               | 91   | \$ 359,000                | \$ 3,944                           | 141       | \$ 543,000                | \$ 3,850                           |
| 4    | CA excluding<br>Honey Lake             | 1,990  | \$5,853,000               | \$2,941                            | 3,041     | \$8,976,000               | \$ 2,951                           |
|      | All California                         | 1,995  | \$5,865,000               | \$2,940                            | 3,048     | \$8,995,000               | \$2,951                            |
|      | All Nevada                             | 802  | \$2,907,000               | \$3,625                            | 1,283     | \$4,454,000               | \$3,472                            |
|      | TOTALS                                 | 2,797  | \$8,772,000               | \$ 3,136                           | 4,331     | \$13,449,000              | \$ 3,106                           |

In this table, total development costs have been rounded to the nearest million dollars.

### **3.0 Conclusions and Recommendations**

#### **3.1. Conclusions**

1. A review of geothermal sites in California and western Nevada indicates that the electrical generation capacity available to the California market from geothermal sources has a minimum value of about 4,700 gross MW and a most-likely value of about 6,200 gross MW. After allowances for generation capacity already on line, the incremental generation capacity available from geothermal sources has a minimum value of about 2,800 gross MW and a most-likely value of about 4,300 gross MW. These estimates are based on information in the public domain or contributed by geothermal developers for the purposes of this study. The estimates may be conservative to the extent that they do not take into account resources about which little or no public-domain information is available.
2. Geothermal sites in California account for about 70% of the incremental generation capacity available. Within California, 90% of the incremental generation capacity identified in this study comes from three areas: the Imperial Valley, The Geysers, and Medicine Lake. The Imperial Valley alone accounts for about 65% of the incremental capacity available in California. Table 15 shows the breakdown of total and incremental generation capacity by specific areas within California and Nevada.
3. For the geothermal sites in the combined California/Nevada study area, the capital cost of incremental generation capacity averaged about \$3,100 per kW installed. Considering just California sites, the average capital cost of incremental generation capacity was somewhat lower: \$2,950 per kW installed. These cost estimates include the following components:
  - Exploration (up to the siting of the first deep, commercial-diameter hole);
  - Confirmation drilling (up to achieving 25% of required capacity at the wellhead);
  - Development drilling (up to achieving 105% of required capacity at the wellhead);
  - Construction of the power plant (including ancillary site facilities); and
  - Transmission-line costs.

The capital cost estimates are only approximate, because each developer would bring its own experience, bias, and opportunities to the development process. Nonetheless, the overall costs per project estimated in this study are believed to be reasonable.

4. The capital cost for specific geothermal projects ranged from about \$1,000/kW (for a small expansion at an existing project) to values in excess of \$6,000/kW (for deep, low-temperature resources at remote locations). Of the 4,300 gross MW of most-likely incremental capacity in the California/Nevada study area, about 2,500 gross MW is available at a capital cost less than the average of

\$3,100/kW. Considering just California sites, about 2,000 gross MW is available at less than the average of \$2,950/kW.

### **3.2. Commercialization Potential**

For the purposes of this study, a capital cost of \$2,400/kW or less is considered competitive with other renewable resources, both for the California/Nevada study area and for the state of California alone. The amount of incremental geothermal capacity available at or below \$2,400/kW is about 1,700 gross MW for the California/Nevada study area, and the same amount (after rounding to the nearest increment of 50 gross MW) for the state of California alone. This amount of geothermal capacity available represents a significant opportunity for commercial development to meet the needs of the California electricity market. Resources with higher estimated costs may also be attractive, depending on market conditions and the mechanisms for implementing California's renewable portfolio standard.

### **3.3. Recommendations**

1. The information in this report should be disseminated among potential purchasers of electrical power in California, including municipal power agencies and investor-owned utilities. This will help ensure that parties entering into contracts for the supply of power from geothermal sites will have a basic understanding of the character of the geothermal resource and the risks associated with development. This understanding will help avoid non-performing contracts.
2. The information in this report should be used to facilitate the aggregation of geothermal projects with other energy sources to achieve lower per-unit costs for transmission from remote sites. A study of options for shared transmission resources is already part of the program of PIER-funded projects being conducted by other contractors in conjunction with Project 1.3.
3. The information in the PIER Geothermal Database should be updated periodically as more information comes into the public domain. This will help ensure that parties relying on the database will be acting on the basis of current information.

### **3.4. Benefits to California**

1. The compilation of geothermal resource data using an objective and consistent methodology should help build momentum for the utilization of these resources and should allow California to benefit from the environmental advantages of this renewable energy source.
2. The PIER Geothermal Database has been created using widely available software (MS Access©) to allow broad dissemination and easy updating as more information comes in to the public domain. This will minimize future programming costs required to keep the database current.

## ENDNOTES

1. The two lists of references that comprise Chapter 6 are copies of the references contained in the PIER Geothermal Database, and are available also therein. Each reference has a unique code number, such as Bal03a or USGSOF99-425, which begins with the first few letters of the name of the primary author, followed by either the year of publication (e.g. 03 = 2003), or other identifying information (e.g., OF99-425 indicates Open File Report 99-425). Most citations within the database refer to this code number, which is usually shorter than the normal bibliographic convention of citing author's surname(s) and year. To conform to the database, these code numbers are also used in this report.
2. If paper copies of these items were to be included for all projects, the length of this report would increase by at least several hundred pages.
3. Acronyms and abbreviations of institutional names and other terms are listed in Chapter 7.
4. The database does include one resource east of Beowawe, which is Hot Sulphur Springs (also known as Tuscarora) in Elko County. This area is probably capable of generating electricity, but it is included by name only: geotechnical data regarding Tuscarora have not been compiled, and its generation capacity has not been estimated. On March 6, 2003, the Public Utilities Commission of Nevada (PUCN) approved a contract between Earth Power Co. and Nevada Power Co., for a 25-MW geothermal power plant at this location (GRCB 32/2 Mar/Apr 2003, p.52).
5. Projects in the database each have a unique 5-character ID code. The first three characters are letters that abbreviate the name of the resource area. The last two characters are a two-digit number that identifies separate projects (development entities or geographic subdivisions) within the resource area. If the number is 00, then the resource area has no more than one (and perhaps no) active development project.
6. In a few cases it is very difficult to assign a most-likely value, so only the minimum and maximum values are assigned, and an equal probability distribution is assumed.
7. The 5-character ID code that is unique to each project is described in Note 5.



# GLOSSARY

## General References

General references are those relevant to methodologies, background data, and regional data and information for California and Nevada. Each reference has a code number that is used for citations made within the PIER Geothermal Database, but these code numbers are not linked to any specific resource area. If a reference has a web address, it is included in the description.

| Code          | Description  |
|---------------|--|
| Bru96a        | Brugman, J., M. Hattar, K. Nichols, and Y. Esaki (1996). Next Generation Geothermal Power Plants, CE Holt Co., Pasadena, CA: February, 1996. Report EPRI TR-106223 (Project 3657-01). Research supported in part by Office of Geothermal Technologies, U.S. Department of Energy.                      |
| CADOGGR       | Public records at website ( <a href="http://www.consrv.ca.gov/dog">www.consrv.ca.gov/dog</a> ) of the California Division of Oil, Gas and Geothermal Resources. These include a database of geothermal wells (exploration and development, all depths), and monthly well production/injection records. |
| Ent03a        | Entingh, D.J., and J.F. McVeigh (2003). Historical improvements in geothermal power system costs. Geothermal Resources Council Transactions, v. 27, October 12-15, 2003, pp.533-537.   |
| Ent97a        | Entingh, D.J. (1997). Geothermal Hydrothermal Electric Systems. In: Renewable Energy Technology Characterizations, U. S. Department of Energy, Washington D.C., and Electric Power Research Institute (EPRI), Palo Alto, CA. EPRI-TR-109496 (Pleasant Hill, CA).                                       |
| Fre00a        | Fredriksens, M., M. Glucina, and R. McMahon (2000). Utilization of second-hand plant to reduce capital investment and project lead times. Proceedings of the World Geothermal Congress 2000, Kyushu-Tohoku, Japan, May 28 - June 10, 2000, pp.3155-3160.   |
| Gaw00a        | Gawlik, K., and C. Kutscher (2000). Investigation of the opportunity for small-scale geothermal power plants in the western United States. Geothermal Resources Council Transactions, v.24, September 24-27, 2000, pp.109-112.   |
| GEO THERM     | U.S. Geological Survey GEO THERM thermal fluids chemistry database (note: this database was maintained by the U.S.G.S until 1983 and does not contain data since that date)  |
| GEx           | GeothermEx company files, information in the public domain.  |
| GHCB, #/#, yr | Geo-Heat Center Quarterly Bulletin, volume/number, year  |
| Gir95a        | Girelli, M., M. Parini, and P. Pisani (1995). Economic evaluation of alternative strategies of geothermal exploitation. Proceedings of the World Geothermal Congress, 1995, v.4, pp.2843-46.   |

## GLOSSARY

| Code             | Description  |
|------------------|--|
| GRCB, #/#, yr    | Geothermal Resources Council Bulletin, volume/number, year.  |
| GRCweb           | Databases of the internet site of the Geothermal Resources Council, <a href="http://www.geothermal.org">www.geothermal.org</a> .   |
| Gri98a           | Greider, R. (1998). Cost factors in geothermal production of electricity. Geothermal Resources Council Bulletin, January/February 1998, pp.14-17.  |
| Hir00a           | Hiriart, G., and J.I. Andaluz (2000). Strategies and economics of geothermal power development in Mexico. Proceedings of the World Geothermal Congress 2000, Kyushi-Tohoku, Japan, May 28 - June 10, 2000, v.2, pp.799-802.  |
| Jen96a           | Jenkins, A.F., R.A. Chapman, and H.E. Reilly (1996). Tax barriers to geothermal and other renewable generation technologies. Geothermal Resources Council Transactions, v.20, September/October 1996, pp.173-182.  |
| Lig95a           | Liguori, P.E. (1995) Economics of geothermal energy. Proceedings of the World Geothermal Congress, 1995, v.4, pp.2837-41. Table 1 - Initial hypothesis.  |
| Mil96a           | Miller, S.A. (1996). Incorporating economic and environmental externalities of geothermal and natural gas generation technologies. Geothermal Resources Council Transactions, v.20, September/October 1996, pp.187-193.  |
| NBMGOF94-2       | Nevada Bureau of Mines and Geology Open-File Report 94-2 (Nevada low-temperature geothermal resource assessment, by L. Garside)<br><a href="http://www.nbmgs.unr.edu/dox/ofr94_2/942.htm">http://www.nbmgs.unr.edu/dox/ofr94_2/942.htm</a> .   |
| NBMGOG           | Oil and gas well database of the Nevada Bureau of Mines and Geology:<br><a href="ftp://ftp.nbmgs.unr.edu/pub/web/oil.htm">ftp://ftp.nbmgs.unr.edu/pub/web/oil.htm</a> .  |
| NVDM or NVDIVMIN | Data files of the Nevada Division of Minerals, Carson City, NV. Geothermal well data that are reported to the Division become public 5 years after the completion date of the well. Much of this information is included in or listed in NVGEOWEL.   |
| NVGEOWEL         | Index to geothermal wells housed at the Nevada Bureau of Mines and Geology: <a href="ftp://ftp.nbmgs.unr.edu/pub/web/nvgeowel.txt">ftp://ftp.nbmgs.unr.edu/pub/web/nvgeowel.txt</a> . Much of the original data listed in this index is also available at NVDM.  |
| Owe02a           | Owens, B. (2002). An economic valuation of a geothermal production tax credit. Geothermal Resources Council Transactions, v.26, September 22-25, 2002, pp.467-471.   |
| Pet93a           | Petty, S., and B. Livesay, (1993). Database of hydrothermal sites in the US with potential for electric power generation. Prepared for: National Renewable Energy Laboratory, Golden, Colorado. By: Susan Petty (Susan Petty Consulting) and Bill Livesay (Livesay Consultants, Inc.). March 23, 1993. |

## GLOSSARY

| Code               | Description   |
|--------------------|---|
| Pra82a             | Prats, M. (1982). Thermal Recovery. Society of Petroleum Engineers of AIME, New York/Dallas.  |
| She00a             | Shevenell, L., L.J. Garside, and R.H. Hess (2000). Nevada Geothermal Resources (map at scale 1:1,000,000). Nevada Bureau of Mines and Geology Map 126.  |
| Sif00a             | Sifford, A., and R.G. Bloomquist (2000). Geothermal electric power production in the United States: a survey and update for 1995-1999. Proceedings of the World Geothermal Congress 2000, Kyushu - Tohoku, Japan, May 28 - June 10, 2000, pp.441-453. |
| SMUWGD             | Southern Methodist University Western Geothermal Database:<br><a href="http://www.smu.edu/geothermal/georesou/usa.htm">http://www.smu.edu/geothermal/georesou/usa.htm</a> .   |
| Ste02a             | Stefánsson, V. (2002). Investment cost for geothermal power plants. Geothermics, v.31, pp.263-272.  |
| Tia96a             | Tiangco, V., P. McCluer, and E. Hughes (1996). Investigation of geothermal energy technologies and gas turbine hybrid estimates. Geothermal Resources Council Transactions, v.20, September/October 1996, pp.195-201.                                 |
| USDOEGT<br>## date | U. S. Department of Energy Geothermal Technologies (newsletter), Volume/Issue, Month and year. (Note: this newsletter is occasionally released as an insert to the GRCB).   |
| USGSC790           | U. S. Geological Survey (1979). Assessment of Geothermal Resources of the United States - 1978. Geological Survey Circular 790. L.J.P. Muffler, Ed.   |
| USGSOF79-<br>1135  | Nehring, N.L., R.H. Mariner, L.D. White, and others (1979). Sulfate Geothermometry of Thermal Waters in the Western United States. U. S. Geological Survey Open-File Report 99-425, Menlo Park, CA.   |
| USGSOF99-<br>425   | U. S. Geological Survey Open-File Report 99-425:<br><a href="http://geopubs.wr.usgs.gov/open-file/of99-425/webmaps/home.html">http://geopubs.wr.usgs.gov/open-file/of99-425/webmaps/home.html</a> .   |
| Whe95a             | Wheble, J., and N. Islam (1995). Recent experience with BOO and BOT geothermal developments. Proceedings of the World Geothermal Congress, 1995, v.4, pp.2895-97.   |

## GLOSSARY

| Code   | Description   |
|--------|---|
| Woo03a | Woodford, D. (2003). Deliverable D1.1.5: Report on AC Collector Grid Configuration and Options. Task 1.1.5: Investigate AC Collector Grid Configuration and Options. Project Team: Electranix Corp, Western Area Power Administration, Winfield Enterprise LLC. Project: Feasibility of Interconnecting to the Pacific HVDC Intertie. Part of the Hetch Hetchy/SFPUC Programmatic Renewable Energy Project. Preliminary and incomplete report - Nov.14th, 2003, by Project Contractor Electranix Corporation and Project Leader Dennis Woodford, and email of related transmission costing data from Woodford to GeothermEx, Dec.4, 2003. |

### Project-Specific References

Project-specific references contain data and information for specific project areas, and are linked to projects within the database using the reference code (REFS\_ID).

| Code   | Description   |
|--------|---|
| Ada84a | Adams, M.C. (1984). Geochemistry of the Wendel-Amedee geothermal system, California. Geothermal Resources Council Transactions, v.8, pp.363-371, August 1984.   |
| Bar76a | Barkman, J.H., D.A. Campbell, J.L. Smith, and R.W. Rex (1976). East Mesa -- geology, reservoir properties and an approach to reserve determination. Proceedings, Second Workshop on Geothermal Reservoir Engineering, Stanford University, Stanford, California, December 1 - 3, 1976. SGP-TR-20, pp.116-125. |
| Bea01a | Beall, J.J., M.C. Adams, and J.L.B. Smith (2001). Geysers reservoir dry out and partial re-saturation evidenced by twenty-five years of tracer tests. Geothermal Resources Council Transactions, v.25, August 26-29, 2001, pp.725-729.  |
| Bea85a | Beall, J.J. (1985). Exploration of a high temperature, fault localized, nonmeteoric geothermal system at the Sulphur Bank Mine, California. Geothermal Resources Council Transactions, v.9, part I, pp.395-401.   |
| Ben82a | Benoit, W.R., J.E. Hiner, and R.T. Forest (1982). Discovery and geology of the Desert Peak geothermal field: a case history. Nevada Bureau of Mines and Geology, Bulletin 97, University of Nevada, Reno.   |
| Ben84a | Benoit, W.R. (1984). Initial results from drill holes PLV-1 and PLV-2 in the western moat of the Long Valley Caldera. Geothermal Resources Council Transactions, v.8, pp.397-402.   |
| Ben93a | Benoit, D., and D. Stock (1993). A case history of injection at the Beowawe, Nevada geothermal reservoir. Geothermal Resources Council Transactions, v. 17, October 10-13, 1993, pp. 473-480.   |

## GLOSSARY

| Code   | Description  |
|--------|--|
| Ben94a | Benoit, D., and P. Hirtz (1994). Non-condensable gas trends and emissions at Dixie Valley, Nevada. Geothermal Resources Council Transactions, v. 18, pp.113-119.   |
| Ben97a | Benoit, D. (1997). Injection-driven restoration of the Beowawe geothermal field. Geothermal Resources Council Transactions, v. 21, October 12-15, 1997, pp. 569-575.   |
| Bir75a | Bird, D.K., and W.A. Elders (1975). Hydrothermal alteration and mass transfer in the discharge portion of the Dunes geothermal system, Imperial Valley of California, USA. Proceedings, Second United Nations Symposium on the Development and Use of Geothermal Resources, San Francisco, California, USA, 20-29 May, 1975, v. 1, pp.285-296.   |
| Bla00a | Blackwell, D. D., B. Gollan, and D. Benoit (2000). Temperatures in the Dixie Valley, Nevada geothermal system. Geothermal Resources Council Transactions, v. 24, September 24-27, 2000, pp. 223-228.   |
| Bla02a | Blackwell, D. D., M. Leidig, R. P. Smith, S. D. Johnson, and K. W. Wisian (2002). Exploration and development techniques for Basin and Range geothermal systems: examples from Dixie Valley, Nevada. Geothermal Resources Council Transactions, v. 26, September 22-25, 2002, pp. 513-518.   |
| BLM00a | BLM (ND). Comment sought on proposed geothermal drilling in Mammoth Lakes area (Posted 10 June 2002). <a href="http://www.ca.blm.gov/bishop/geodrilling.htm">http://www.ca.blm.gov/bishop/geodrilling.htm</a>  |
| BLM01a | BLM (2001). Geothermal drilling in Mammoth Lakes area approved (For Release: February 22, 2001). <a href="http://www.ca.blm.gov/news/2002/02/nr/USFS_BLMnews_mammoth_geothermal">http://www.ca.blm.gov/news/2002/02/nr/USFS_BLMnews_mammoth_geothermal</a>   |
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## GLOSSARY

### Database Data Abbreviations and Definitions

The following table is also available in the PIER Geothermal Database, at the command button Abbreviations and Definitions.

| Abbreviation             | Definition   |
|--------------------------|--|
| AMT                      | Audio-MagnetoTelluric resistivity survey. A method of geophysical exploration at the land surface that determines resistivity within the earth.  |
| BL (or bl)               | Blank well liner (no slots) (uncemented unless otherwise annotated)  |
| BLM or USBLM             | United States Bureau of Land Management  |
| CADOGGR                  | California Division of Oil, Gas and Geothermal Resources   |
| Energy Commission or CEC | California Energy Commission (the abbreviation CEC is used in the database only, not in narrative sections of the final report.)   |
| CSAMT                    | Controlled-Source Audio-MagnetoTelluric resistivity survey. A method of geophysical exploration at the land surface that determines resistivity within the earth.  |
| Csg                      | Well casing (cemented)   |
| DC (Resistivity)         | Direct Current. In reference to any one of several types of DC resistivity surveys (e.g. Dipole, roving dipole, Schlumberger). A method of geophysical exploration at the land surface that determines resistivity within the earth. |
| GCS                      | Geothermal Cost Survey, conducted by the California Energy Commission in 1993.   |
| HFU                      | Heat Flow Units (1 HFU = $10^{-6}$ calories per $\text{cm}^2\text{-sec.}$ ). A measurement of heat flow from the earth.  |
| ID                       | Intermediate Depth or Internal Diameter (used to describe the design of a well)  |

## GLOSSARY

| Abbreviation | Definition   |
|--------------|--|
| ID Slim      | Intermediate-Depth Slim hole. In this database, loosely refers to a hole with TD greater than 2,000 ft (see further), but too narrow to support a commercial level of flow if permeability is encountered. Such a hole may or may not have been designed to allow injection tests or flow tests. TD may reach 4,000 to 5,000 ft, but is rarely deeper. Includes deep core holes, relatively deep TG (temperature gradient) holes, and so-called "Strat Tests" (stratigraphy tests). At some projects, a hole or a set of holes between 1,000 and 2,000 ft deep has been classified as ID Slim, if other holes in the same area are all decidedly shallower (say, $\leq 500$ ft). This is because exploration often starts with drilling holes that are a maximum 500 ft deep (for cost and regulatory reasons), then later (at selected targets) includes holes that are 1,000 to 2,000 ft deep. In addition, a set of holes may be classified as ID Slim holes, even if it includes some that are less than 1,000 ft deep, if the number of deeper holes in the set is regarded as significant, and there is no particular reason to separately classify and describe the shallower holes in the set. See also the definition of TG hole. |
| INEL/INEEL   | Idaho National Engineering Laboratory. Later renamed to Idaho National Engineering and Environmental Laboratory  |
| ISO          | Isothermal (used to refer to a condition of constant temperature between two different levels in the subsurface (in a reservoir)).   |
| KGRA         | Known Geothermal Resource Area (Per Section 4 of the Federal Geothermal Steam Act). An area designated by the USGS as having potential for beneficial exploitation of the geothermal resource suspected to exist in the area.  |
| LC           | Lost Circulation (loss of drilling fluid circulation during drilling). Indicates that drilling fluid must be entering the formation.   |
| Lith         | Lithology (the kind of rock drilled by a well or exposed at the land surface)  |
| LLNL         | Lawrence Livermore National Laboratory   |
| Max          | Maximum (referring to the maximum value of an estimate)  |
| Min          | Minimum (referring to the minimum value of an estimate). In the case of generation capacity, this refers to the Monte Carlo estimate with a cumulative probability of 90% (see Appendix III).  |
| Mlk          | Most-likely (referring to the most-likely value of an estimate). In the case of generation capacity, this refers to the Monte Carlo most-frequently estimated value (see Appendix III for how this is determined.)   |

## GLOSSARY

| Abbreviation  | Definition   |
|---------------|--|
| msl           | Mean sea level (elevation above or below)  |
| MT            | MagnetoTelluric resistivity survey. A method of geophysical exploration at the land surface that determines resistivity within the earth.  |
| N or Note     | Refers to a numbered comment in the same record  |
| N/A           | Not Applicable or Not Available  |
| OH            | Open Hole. The bottom portion of a well, which is not cased (lined with cemented casing) or lined (lined with uncemented casing). Some wells may not have any open hole, particularly if lined at the bottom with a slotted liner. |
| P&A           | Plugged and Abandoned (said of a well)   |
| PB or pb      | Plugged Back. A drilling operation in which the lower-most portion of a well is plugged back to some specified level.  |
| PIER          | Public Interest Energy Research. A program of the California Energy Commission.  |
| power density | Generation capacity expressed as MW/square mile.   |
| PZ            | Permeable Zone or Production Zone. A depth zone in a well that is permeable (can receive or give fluid to the formation), or produces fluid to the wellhead.   |
| RD            | Re-drill (of a well), usually following the development of mechanical problems or scale deposition. Usually involves plugging the well at some level and "kicking-off" to establish a new hole adjacent to the abandoned portion.  |
| SFPUC         | San Francisco Public Utilities Commission  |
| SIWHP         | Shut-in wellhead pressure. The wellhead pressure of a well that is shut-in (not flowing).  |
| SL (or sl)    | Slotted well liner (uncemented unless otherwise annotated)   |
| SP (or ESP)   | (Electrical) Self-Potential survey. A type of geophysical survey at the land surface that measures rock properties in the subsurface.  |
| T             | Temperature. All temperatures in the PIER Geothermal Database are expressed in degrees Fahrenheit.   |

## GLOSSARY

| Abbreviation       | Definition  |
|--------------------|---|
| TD                 | Total Depth or Total Discharge. With respect to total depth, used herein to refer to drilled depth, which is greater than the true vertical depth (TVD) in a deviated well.   |
| TDEM               | Time-Domain ElectroMagnetic survey. A method of geophysical exploration at the land surface that determines resistivity within the earth.   |
| TDS                | Total Dissolved Solids  |
| TG                 | Temperature gradient. The relationship between temperature and depth, moving downwards in the earth. Expressed in this database as °F/100ft.  |
| TG hole            | Temperature-gradient hole. In this database, loosely refers to a hole less than 1,000 ft deep, drilled only (or primarily) to measure temperature gradient and not designed for flow tests. Most often equal to or less than 500 ft deep but occasionally in the range 1,000 to 2,000 ft. Most TG holes deeper than 1,000 ft have been classified herein as ID Slim holes (see), to distinguish them from shallower holes usually drilled during an earlier phase of exploration. |
| TMF                | Total mass flow. The combined flow of water and steam from a well.  |
| TVD                | True vertical depth. Used to distinguish elevation difference, as opposed to drilled distance, in a deviated hole.  |
| USBLM or BLM       | United States Bureau of Land Management   |
| USGS (or U.S.G.S.) | United States Geological Survey   |
| WHP                | Wellhead pressure   |

## **LIST OF APPENDICES**

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Table IV-2: Totals of full-diameter, production and injection wells at geothermal fields in California and Nevada

Appendix V. Exploration, Confirmation and Development Costs – Detail by Project (example)

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Appendix VII. How to Use the Database / Technical Information

### **Attachment**

PIER Geothermal Database (MS Access©).....CD in pocket



**Appendix I**  
**Database Figure List by Project**



**Hetch Hetchy/SFPUC Programmatic Renewable Energy Project**  
**Project: 1.3 New Geothermal Site Identification and Qualification**  
**Project Team: GeothermEx, Inc.**  
**Task: 1.3.10 Final Project Report**  
**Subject: D.1.3.10.3 Final Report**

## Appendix I. Database Figure List by Project

| <b>Proj</b>  | <b>Figure</b>   |
|--------------|---|
| <b>ADO00</b> | <b>Adobe Valley (Granite Springs V. - N. End)</b>   |
|              | ADO00-1 Map showing hole locations and temperature data, Adobe Valley (Granite Springs Valley) area, Nevada |
| <b>AUR00</b> | <b>Aurora</b>   |
|              | AUR00-1 Locations of temperature gradient holes in the Aurora prospect area                                 |
|              | AUR00-2 Downhole temperature logs from the Aurora prospect area   |
|              | AUR00-3 Probabilistic calculation of geothermal energy reserves, Aurora prospect, Nevada                    |
| <b>BAL00</b> | <b>Baltazor</b>   |
|              | BAL00-1 Downhole temperatures near Baltazor Hot Spring  |
|              | BAL00-2 Geologic map of the Baltazor Hot Springs area   |
|              | BAL00-3 Downhole lithology, temperature and geologic section in the Baltazor Hot Springs area               |
|              | BAL00-4 Probabilistic calculation of geothermal energy reserves, Baltazor Hot Springs, Nevada               |
| <b>BEO00</b> | <b>Beowawe</b>  |
|              | BEO00-1 Well location map, Beowawe geothermal field   |
|              | BEO00-2 Beowawe initial-state temperatures within Malpais fault zone  |
|              | BEO00-3 Probabilistic calculation of geothermal energy reserves, Beowawe, Nevada                            |
| <b>BLU00</b> | <b>Blue Mountain</b>  |
|              | BLU00-1 Map showing location of Blue Mountain geothermal leases   |
|              | BLU00-2 Map showing bore hole locations   |
|              | BLU00-3 Geologic map and gradient hole information  |
|              | BLU00-4 Downhole temperatures at the Blue Mountain geothermal area  |
|              | BLU00-5 Probabilistic calculation of geothermal energy reserves, Blue Mountain, Nevada                      |
| <b>BRA00</b> | <b>Brady's Hot Springs</b>  |
|              | BRA00-1 Well locations and surface temperature anomaly, Brady's Hot Springs, Nevada                         |
|              | BRA00-2 Approximate elevation of 350°F isotherm, Brady's Hot Springs, Nevada                                |
|              | BRA00-3 Probabilistic calculation of geothermal energy reserves, Bradys Hot Springs, Nevada                 |
| <b>BRW00</b> | <b>Brawley Area-wide summary</b>  |

| <b>Proj</b>            | <b>Figure</b>  |
|------------------------|--|
| BRW00-1                | Locations of the geothermal anomalies of the Imperial Valley, California   |
| BRW00-2                | Total depths and bottomhole temperatures of deep holes in the Salton Sea, Brawley and Westmorland areas of the Imperial Valley, California |
| <b>BRW01 Brawley</b>   | <b>Brawley (North Brawley)</b>   |
| BRW00-1                | Locations of geothermal areas of the Imperial Valley, California   |
| BRW00-2                | Total depths and bottomhole temperatures of deep holes in the Salton Sea, Brawley and Westmorland areas of the Imperial Valley, California |
| BRW01-1                | Deep well data: (North) Brawley area, Imperial Valley, California  |
| BRW01-2                | Probabilistic calculation of geothermal energy reserves, (North) Brawley geothermal area, California                                       |
| <b>BRW02 Brawley</b>   | <b>East Brawley</b>  |
| BRW00-1                | Locations of geothermal areas of the Imperial Valley, California   |
| BRW00-2                | Total depths and bottomhole temperatures of deep holes in the Salton Sea, Brawley and Westmorland areas of the Imperial Valley, California |
| BRW02-1                | Heat flow map and well data, East Brawley geothermal area, California  |
| BRW02-2                | Deep well data: East Brawley area, Imperial Valley, California   |
| BRW02-3                | Probabilistic calculation of geothermal energy reserves, East Brawley geothermal area, California  |
| <b>BRW03 Brawley</b>   | <b>South Brawley (Mesquite field)</b>  |
| BRW00-1                | Locations of geothermal areas of the Imperial Valley, California   |
| BRW00-2                | Total depths and bottomhole temperatures of deep holes in the Salton Sea, Brawley and Westmorland areas of the Imperial Valley, California |
| BRW03-1                | Deep well data: South Brawley area, Imperial Valley, California  |
| BRW03-2                | Geologic map of the southern Imperial Valley, California   |
| BRW03-3                | Probabilistic calculation of geothermal energy reserves, South Brawley geothermal area, California   |
| <b>CAL00 Calistoga</b> |  |
| CAL00-1                | Map showing the general location of the Calistoga geothermal field in the upper Napa Valley, California                                    |
| CAL00-2                | Map of the Calistoga area showing chemical and temperature anomalies   |
| CAL00-3                | Downhole well temperatures and diagrammatic cross-section of the Calistoga geothermal field, Napa Valley, California                       |
| CAL00-4                | Probabilistic calculation of geothermal energy reserves, Calistoga area, Napa County, California   |
| <b>COL00 Colado</b>    |  |
| COL00-1                | Map showing hole locations and temperature data, Colado area, Nevada   |
| COL00-2                | Probabilistic calculation of geothermal energy reserves, Colado area, Nevada   |
| <b>COS00 Coso</b>      | <b>Field-wide Summary</b>  |

| <b>Proj</b>  | <b>Figure</b>  |
|--------------|--|
| COS00-1      | Coso lease areas and outline of 350°F temperature contour at sea level   |
| COS00-2      | Probabilistic calculation of geothermal energy reserves, Coso, California  |
| COS00-3      | Historical power output of Coso field  |
| <b>DES00</b> | <b>Desert Peak</b>   |
| DES00-1      | Well and fault location map, showing project areas, Desert Peak, Nevada  |
| DES00-2      | Geologic and temperature cross section, Desert Peak, Nevada  |
| DES00-3      | Map showing possible reservoir boundaries, Desert Peak, Nevada   |
| DES00-4      | Probabilistic calculation of geothermal energy reserves, Desert Peak, Nevada   |
| <b>DIX00</b> | <b>Dixie Valley</b><br><b>Caithness Dixie Valley</b>   |
| DIX00-1      | Well location map, Dixie Valley geothermal field   |
| DIX00-2      | Observed temperature distribution at -4,000 ft (msl), Dixie Valley   |
| DIX00-3      | Observed temperature distribution at -5,000 ft (msl), Dixie Valley   |
| DIX00-4      | Observed temperature distribution at -6,000 ft (msl), Dixie Valley   |
| DIX00-5      | Map showing shallow-to-intermediate depth hole locations and temperature data, Dixie Valley, Nevada  |
| DIX00-6      | Probabilistic calculation of geothermal energy reserves, Dixie Valley (Caithness project area), Nevada                                       |
| <b>DIX01</b> | <b>Dixie Valley</b><br><b>Dixie Valley Power Partners (DVPP)</b>   |
| DIX01-1      | Shallow thermal gradient contours and temperature cross-section of the Dixie Valley Power Partners area                                      |
| DIX01-2      | Probabilistic calculation of geothermal energy reserves, Dixie Valley (Dixie Valley Power Partners project area), Nevada                     |
| <b>DOU00</b> | <b>Double - Black Rk Hot Springs</b>   |
| DOU00-1      | Map showing hole locations and temperature data, Double - Black Rock Hot Springs area, Nevada  |
| DOU00-2      | Probabilistic calculation of geothermal energy reserves, Double - Black Rock Hot Springs, Nevada   |
| <b>DUN00</b> | <b>Dunes</b>   |
| BRW00-1      | Locations of geothermal areas of the Imperial Valley, California   |
| DUN00-1      | Hole locations and downhole temperature logs, Dunes geothermal anomaly, Imperial County, California  |
| DUN00-2      | Temperature and lithologic cross-sections, Dunes geothermal anomaly, Imperial County, California   |
| DUN00-3      | Temperature profile of hole DWR No.1 and schematic diagram of the hydrothermal system, Dunes geothermal anomaly, Imperial County, California |
| DUN00-4      | Probabilistic calculation of geothermal energy reserves, Dunes anomaly, California   |
| <b>EAS00</b> | <b>East Mesa</b><br><b>Field-wide summary</b>  |

| <b>Proj</b>  | <b>Figure</b>   |
|--------------|---|
| BRW00-1      | Locations of geothermal areas of the Imperial Valley, California  |
| EAS00-1      | Temperature contours in the East Mesa geothermal field, California  |
| EAS00-2      | Downhole temperature logs of wells 6-1, 6-2 and 5-1, East Mesa geothermal field, California                   |
| EAS00-3      | Downhole temperature logs of wells 8-1 and 31-1, East Mesa geothermal field, California                       |
| EAS00-4      | S-N vertical temperature section, East Mesa geothermal field, California                                      |
| EAS00-5      | Probabilistic calculation of geothermal energy reserves, East Mesa geothermal field, California               |
| <b>EMI00</b> | <b>Emigrant (Fish Lake V.)</b>  |
| EMI00-1      | Map showing hole locations and temperature data, Emigrant prospect, Fish Lake Valley, Nevada - SMU data set   |
| EMI00-2      | Map showing hole locations and temperature data, Emigrant prospect, Fish Lake Valley, Nevada - FLGPC data set |
| EMI00-3      | Probabilistic calculation of geothermal energy reserves, Emigrant (Fish Lake Valley) area, Nevada             |
| <b>EMP00</b> | <b>Empire (San Emidio)                      Field-wide summary</b>  |
| EMP00-1      | Well locations and thermal anomaly, Empire geothermal area, Nevada  |
| EMP00-2      | Probabilistic calculation of geothermal energy reserves, Empire (San Emidio) area, Nevada                     |
| <b>FAL00</b> | <b>Fallon / Carson Lake                      Carson Lake anomaly</b>  |
| FAL00-1      | Temperatures to 7,000 ft at SE corner of Naval Air Station  |
| FAL00-2      | Shallow temperature anomaly at Fallon / Carson Lake   |
| FAL00-3      | Map showing hole locations, temperature data and boundaries of Fallon NAS                                     |
| FAL00-4      | Map showing reflection seismic lines and inferred fault zones, Fallon NAS area,                               |
| FAL00-5      | Map showing land use in Fallon NAS area, Nevada   |
| FAL00-6      | Probabilistic calculation of geothermal energy reserves, Fallon (Carson Lake) anomaly, Nevada                 |
| <b>FIS00</b> | <b>Fish Lake (Valley)</b>   |
| FIS00-1      | Map showing hole locations and temperature data, Fish Lake Valley, Nevada                                     |
| FIS00-2      | Probabilistic calculation of geothermal energy reserves, Fish Lake Valley, Nevada                             |
| <b>FLY00</b> | <b>Fly Ranch/Granite Ranch                      Ward's (Fly/Hualapi Flat) H.S.</b>                            |
| FLY00-1      | Map showing hole locations and temperature data, Fly Ranch area, Nevada                                       |
| FLY00-2      | Downhole temperatures in Holland Ranch 1-2-FR and Cordero Fly No.3  |
| FLY00-3      | Probabilistic calculation of geothermal energy reserves, Fly Ranch (Ward's H.S.) area, Nevada                 |
| <b>FLY01</b> | <b>Fly Ranch/Granite Ranch                      Granite Ranch</b>   |

| <b>Proj</b>  | <b>Figure</b>  |
|--------------|--|
| FLY00-1      | Map showing hole locations and temperature data, Fly Ranch area, Nevada  |
| FLY00-2      | Downhole temperatures in Holland Ranch 1-2-FR and Cordero Fly No.3   |
| FLY01-1      | Probabilistic calculation of geothermal energy reserves, Fly Ranch / Granite Ranch area, Nevada                  |
| <b>GER00</b> | <b>Gerlach (Great Boiling Spring)</b>  |
| GER00-1      | Map showing hole locations and temperature data, Gerlach (Great Boiling Springs) area, Nevada                    |
| GER00-2      | Probabilistic calculation of geothermal energy reserves, Gerlach Area, Nevada                                    |
| <b>GEY00</b> | <b>Geysers Field-wide Summary</b>  |
| GEY00-1      | Location of power plants and Unit Areas at The Geysers   |
| GEY00-2      | Location map showing the position of The Geysers steam field and "felsite" pluton relative to regional structure |
| GEY00-3      | Maps showing top of felsite and top of steam reservoir at The Geysers steam field                                |
| GEY00-4      | Vertical sections through Units 13, 16 and Bear Canyon, showing wellbore traces and steam entry elevations       |
| GEY00-5      | Non-condensable gas concentration in early steam production from the Northwest Geysers                           |
| GEY00-6      | Calpine Unit areas steam production and injection history  |
| GEY00-7      | Field-wide Geysers steam production and injection history  |
| GEY00-8      | Geysers fieldwide monthly injection fraction   |
| <b>GLA00</b> | <b>Glamis</b>  |
| BRW00-1      | Locations of geothermal areas of the Imperial Valley, California   |
| GLA00-1      | Probabilistic calculation of geothermal energy reserves, Glamis geothermal anomaly, California                   |
| <b>HAW0</b>  | <b>Hawthorne</b>   |
| HAW00-1      | Map showing hole locations and temperature data, Hawthorne area, Nevada (SMU data)                               |
| HAW00-2      | Map showing hole locations and temperature data, Hawthorne area, Nevada (GPO data)                               |
| HAW00-3      | Temperature logs and cross-section, Hawthorne area, Nevada (GPO)   |
| HAW00-4      | Probabilistic calculation of geothermal energy reserves, Hawthorne area, Nevada                                  |
| <b>HAZ00</b> | <b>Hazen (Black Butte) (Patua Hot Springs)</b>   |
| HAZ00-1      | Probabilistic calculation of geothermal energy reserves, Hazen (Black Butte / Patua H.S.) area, Nevada           |
| <b>HEB00</b> | <b>Heber Field-wide Summary</b>  |
| BRW00-1      | Locations of geothermal areas of the Imperial Valley, California   |
| HEB00-1      | Temperature and permeability models of the Heber geothermal field, California                                    |

| <b>Proj</b>  | <b>Figure</b>   |
|--------------|---|
| HEB00-2      | Temperature cross-sections through the Heber geothermal field   |
| HEB00-3      | Probabilistic calculation of geothermal energy reserves, Heber field, California                            |
| <b>HON00</b> | <b>Honey Lake</b>   |
|              | <b>Area-wide Summary</b>  |
| HON00-1      | Map showing hole locations and temperature data, Honey Lake (Wendel-Amedee H.S.) area, California           |
| HON00-2      | NW-SE cross section through the Wendel-Amedee geothermal area, California                                   |
| HON00-3      | Downhole temperature data, Honey Lake (Wendel-Amedee H.S.) area, California                                 |
| HON00-4      | Probabilistic calculation of geothermal energy reserves, Honey Lake (Wendel - Amedee H.S.) area, California |
| <b>HYD00</b> | <b>Hyder Hot Springs</b>  |
| HYD00-1      | Map showing hole locations, temperature and lease information, Hyder Hot Springs, Dixie Valley, Nevada      |
| HYD00-2      | Probabilistic calculation of geothermal energy reserves, Hyder Hot Springs, Nevada                          |
| <b>KYL00</b> | <b>Kyle Hot Springs (Granite Mtn.) (Buena Vista Valley)</b>   |
| KYL00-1      | Location map with lease position and downhole temperature information, Kyle Hot Springs, Nevada             |
| KYL00-2      | Probabilistic calculation of geothermal energy reserves, Kyle Hot Springs, Nevada                           |
| <b>LAK00</b> | <b>Lake City / Surprise Valley</b>  |
|              | <b>Lake City</b>  |
| LAK00-1      | Map showing hole locations and temperature data, Lake City (Surprise Valley) area, California               |
| LAK00-2      | Cross section showing temperature, Lake City (Surprise Valley) area, California                             |
| LAK00-3      | Regional tectonic features, Lake City (Surprise Valley) area, California                                    |
| LAK00-4      | Probabilistic calculation of geothermal energy reserves, Lake City / Surprise Valley, California            |
| <b>LEA00</b> | <b>Leach Hot Springs</b>  |
|              | <b>Grass Valley</b>   |
| LEA00-1      | Summaries of exploration data at Leach Hot Springs (Sorey and Olmsted, 1994)                                |
| LEA00-2      | Map showing hole locations, depth and lease position, Leach Hot Springs, Grass Valley, Nevada               |
| LEA00-3      | Map showing bottom hole temperatures, Leach Hot Springs, Grass Valley, Pershing County, Nevada              |
| LEA00-4      | Map showing temperature gradients , Leach Hot Springs, Grass Valley, Pershing County, Nevada                |
| LEA00-5      | Probabilistic calculation of geothermal energy reserves, Leach Hot Springs, Nevada                          |
| <b>LEE00</b> | <b>Lee Hot Springs</b>  |
| LEE00-1      | Probabilistic calculation of geothermal energy reserves, Lee Hot Springs, Nevada                            |
| <b>LVM00</b> | <b>Long Valley - M-P Leases</b>   |
|              | <b>M-P Lease Summary</b>  |
| LVM00-1      | Location of Mammoth-Pacific leases in the western half of Long Valley                                       |

| <b>Proj</b>  | <b>Figure</b>  |  |
|--------------|--|--|
| LVM00-2      | Examples of published temperature logs from the western half of the Long Valley caldera                              |  |
| LVM00-3      | Approximate temperature distribution at +6,500 ft msl, in the western half of Long Valley                            |  |
| LVM00-4      | Approximate temperature distribution at +5,500 ft msl, in the western half of Long Valley                            |  |
| LVM00-5      | Approximate temperature distribution at +5,000 ft msl, in the western half of Long Valley                            |  |
| LVM00-6      | Probabilistic calculation of geothermal energy reserves in the western half of Long Valley                           |  |
| <b>LVM01</b> | <b>Long Valley - M-P Leases</b>  | <b>Basalt Canyon Expl. Project</b>       |
| LVM01-1      | Drill sites of proposed Basalt Canyon Exploration Project  |  |
| <b>LVM02</b> | <b>Long Valley - M-P Leases</b>  | <b>Upper Basalt Canyon Expl. Project</b> |
| LVM02-1      | Drill sites of proposed Upper Basalt Canyon Exploration Project  |  |
| <b>MCF00</b> | <b>McFarlanes Hot Spring</b>   | <b>(Black Rock Desert)</b>               |
| MCF00-1      | Map showing hole locations and temperature data, McFarlanes (McFarlans) area, Nevada                                 |  |
| <b>MCG0</b>  | <b>McGee Mountain</b>  | <b>(Painted Hills)</b>                   |
| MCG00-1      | Map showing hole locations and temperature data, McGee Mountain (Painted Hills) area, Nevada                         |  |
| MCG00-2      | Probabilistic calculation of geothermal energy reserves, McGee Mountain (Painted Hills) area, Nevada                 |  |
| <b>MED00</b> | <b>Medicine Lake</b>   | <b>Field-wide Summary</b>                |
| MED00-1      | Map showing hole locations, project areas and temperature contours, Medicine Lake area, California                   |  |
| MED00-2      | Probabilistic calculation of geothermal energy reserves, Medicine Lake Caldera, California                           |  |
| <b>MED01</b> | <b>Medicine Lake</b>   | <b>Fourmile Hill</b>                     |
| MED01-1      | Temperature data from hole 88-28, Fourmile Hill project area   |  |
| MED01-2      | Probabilistic calculation of geothermal energy reserves, Fourmile Hill Area, Medicine Lake, California               |  |
| <b>MED02</b> | <b>Medicine Lake</b>   | <b>Telephone Flat</b>                    |
| MED02-1      | Locations of existing and proposed drill holes in the Telephone Flat project area, Medicine Lake volcano, California |  |
| MED02-2      | Downhole temperature data from the Telephone Flat project area, Medicine Lake volcano, California                    |  |
| MED02-3      | Probabilistic calculation of geothermal energy reserves, Telephone Flat Area, Medicine Lake, California              |  |
| <b>MOS00</b> | <b>Mount Signal</b>  |  |

| <b>Proj</b>   | <b>Figure</b>  |
|---|--|
| MOS00-1   | Geology and isograd contours, Mt. Signal geothermal area   |
| MOS00-2   | Lease map with isograd contours, Mt. Signal geothermal area  |
| MOS00-3   | Temperature profile, Mt. Signal Strat. No.1  |
| MOS00-4   | Probabilistic calculation of geothermal energy reserves, Mt. Signal, Imperial County, California   |
| <b>NEW00 New York Canyon</b>  |  |
| NEW00-1   | Map showing property boundaries, temperature hole locations and data, New York Canyon, Nevada  |
| NEW00-2   | Probabilistic calculation of geothermal energy reserves, New York Canyon area, Nevada  |
| <b>NIL00 Niland</b>   |  |
| BRW00-1   | Locations of geothermal areas of the Imperial Valley, California   |
| BRW00-2   | Total depths and bottomhole temperatures of deep holes in the Salton Sea, Brawley and Westmorland areas of the Imperial Valley, California   |
| NIL00-1   | Probabilistic calculation of geothermal energy reserves, Niland geothermal area, California  |
| SAL00-1   | Hole locations and shallow gradient maps of the Salton Sea geothermal field, California (showing also the locations of Niland project wells) |
| <b>NOR00 North Valley</b>   |  |
| NOR00-1   | Map showing hole locations and temperature data, North Valley area, Nevada   |
| NOR00-2   | Probabilistic calculation of geothermal energy reserves, North Valley area, Nevada   |
| <b>PIN00 Pinto Hot Springs</b>                                      |  |
| PIN00-1   | Map showing hole locations and temperature data, Pinto Hot Springs area (Black Rock Desert), Nevada  |
| PIN00-2   | Probabilistic calculation of geothermal energy reserves, Pinto Hot Springs (Black Rock Desert), Nevada                                       |
| <b>PIR00 Pirouette Mountain (S.Dixie Valley)</b>                    |  |
| PIR00-1   | Map showing hole locations and temperature data, Pirouette Mountain area, southern Dixie Valley, Nevada                                      |
| PIR00-2   | Probabilistic calculation of geothermal energy reserves, Pirouette Mountain area (southern Dixie Valley), Nevada                             |
| <b>PUM00 Pumpnickel Valley Tipton Ranch/Hot Springs Ranch</b>       |  |
| PUM00-1   | Map showing hole locations and temperature data, Pumpnickel Valley (Tipton Ranch) area, Nevada   |
| PUM00-2   | Probabilistic calculation of geothermal energy reserves, Pumpnickel Valley (Tipton Ranch), Nevada  |
| <b>PYR00 Pyramid Lake Indian Reserv. (Needle Rocks Hot Springs)</b> |  |
| PYR00-1   | Map showing spring and well locations and temperature data, Pyramid Lake area, Nevada  |

| <b>Proj</b>                                    | <b>Figure</b>   |
|--|---|
| PYR00-2  | Probabilistic calculation of geothermal energy reserves, Pyramida Lake (Needles H.S.) area, Nevada  |
| <b>RAN00 Randsburg</b>                         |   |
| RAN00-1  | Map showing hole locations and temperature data, Randsburg area, California   |
| RAN00-2  | Probabilistic calculation of geothermal energy reserves, Randsburg area, California   |
| <b>RYE00 Rye Patch-Humboldt House District</b> | <b>Field-wide summary</b>   |
| RYE00-1  | Map showing hole locations and temperature data, Rye Patch - Humboldt House district, Nevada  |
| <b>RYE01 Rye Patch-Humboldt House District</b> | <b>Rye Patch</b>  |
| RYE01-1  | Probabilistic calculation of geothermal energy reserves, Rye Patch area, Nevada   |
| <b>RYE02 Rye Patch-Humboldt House District</b> | <b>Humboldt House</b>   |
| RYE02-1  | Probabilistic calculation of geothermal energy reserves, Humboldt House, Nevada   |
| <b>SAL00 Salton Sea</b>                        | <b>Field-wide summary</b>   |
| BRW00-2  | Total depths and bottomhole temperatures of deep wells in the Salton Sea, Brawley, Niland and Westmoreland areas of the Imperial Valley, California |
| SAL00-1  | Hole locations and shallow thermal gradient maps of the Salton Sea geothermal area, California  |
| SAL00-2  | Map showing geographic areas used for capacity estimate, Salton Sea geothermal field, California  |
| SAL00-3  | Probabilistic calculation of geothermal energy reserves, Salton Sea field, California   |
| <b>SAW00 Salt Wells</b>                        | <b>Eight Mile Flat</b>  |
| SAW00-1  | Map showing hole locations and temperature data, Salt Wells Basin, Nevada   |
| SAW00-2  | Probabilistic calculation of geothermal energy reserves, Salt Wells Basin, Nevada   |
| <b>SES00 Sespe Hot Springs</b>                 |   |
| SES00-1  | Probabilistic Calculation of Geothermal Energy Reserves, Sespe Hot Springs, Ventura County, California  |
| <b>SHO00 Shoshone-Reese River</b>              |   |
| SHO00-1  | Map showing hole locations and temperature data, Shoshone-Reese River area, Nevada  |
| SHO00-2  | Probabilistic calculation of geothermal energy reserves, Shoshone - Reese River area, Nevada  |
| <b>SIL00 Silver Peak</b>                       | <b>(Alum prospect)</b>  |
| SIL00-1  | Map showing hole locations and temperature data, greater Silver Peak area, Nevada   |
| SIL00-2  | Map showing hole locations and temperature data, Alum (Silver Peak) prospect area, Nevada   |
| SIL00-3  | Probabilistic calculation of geothermal energy reserves, Silver Peak (Alum Prospect), Nevada  |

| <b>Proj</b>  | <b>Figure</b>   |                                      |
|--------------|---|--------------------------------------|
| <b>SOD00</b> | <b>Soda Lake</b>  | <b>Soda Lake No.1/No.2</b>           |
| SOD00-1      | Well location map, Soda Lake, Nevada  |                                      |
| SOD00-2      | Approximate temperature distribution at +2,000 ft (msl), Soda Lake, Nevada  |                                      |
| SOD00-3      | Approximate temperature distribution at sea level, Soda Lake, Nevada  |                                      |
| SOD00-4      | Probabilistic calculation of geothermal energy reserves, Soda Lake, Nevada  |                                      |
| <b>SOH00</b> | <b>Sou Hot Springs</b>  | <b>(Seven Devils/Gilbert's H.S.)</b> |
| SOH00-1      | Map showing hole locations and temperatures, Sou Hot Springs, Dixie Valley, Nevada  |                                      |
| SOH00-2      | Probabilistic calculation of geothermal energy reserves, Sou Hot Springs, Dixie Valley, Nevada                                    |                                      |
| <b>STE00</b> | <b>Steamboat Hot Sprs</b>   | <b>Field-wide Summary</b>            |
| STE00-1      | Well and lease location map, Steamboat geothermal field, Nevada   |                                      |
| STE00-2      | Approximate initial temperature distribution at +4,000 feet (msl), Steamboat geothermal field, Nevada                             |                                      |
| STE00-3      | Approximate extent of the 320°F isotherm at +3,500 feet (msl), Steamboat geothermal field, Nevada                                 |                                      |
| STE00-4      | Probabilistic calculation of geothermal energy reserves, Steamboat Hot Springs field, Nevada                                      |                                      |
| <b>STI00</b> | <b>Stillwater</b>   | <b>Stillwater Geothermal 1</b>       |
| STI00-1      | Well locations and temperature contours, Stillwater, Nevada   |                                      |
| STI00-2      | Probabilistic calculation of geothermal energy reserves, Stillwater field, Nevada   |                                      |
| <b>STI01</b> | <b>Stillwater</b>   | <b>Stillwater N Expansion</b>        |
| STI00-1      | Well locations and temperature contours, Stillwater, Nevada   |                                      |
| STI01-1      | Probabilistic calculation of geothermal energy reserves, Stillwater N Expansion, Nevada   |                                      |
| <b>SUL00</b> | <b>Sulphur Bank</b>   | <b>Clear Lake</b>                    |
| SUL00-1      | Geologic map of the Sulphur Bank Mine- Borax Lake area, with locations of four exploration test wells and lines of cross-sections |                                      |
| SUL00-2      | Geologic map of Sulphur Bank Mine, geologic cross-section A-A', pattern of fault intersections, and area of gas leakage           |                                      |
| SUL00-3      | Isothermal cross-sections   |                                      |
| SUL00-4      | Contoured temperature in °F at a depth of 100 feet.   |                                      |
| SUL00-5      | Probabilistic calculation of geothermal energy reserves, Sulphur Bank anomaly, Clear Lake region, California                      |                                      |
| <b>SUP00</b> | <b>Superstition Mountain</b>  |                                      |
| SUP00-1      | Geology and isotherms at Superstition Mountain  |                                      |
| SUP00-2      | Lease map with isotherm contours, Superstition Mountain   |                                      |

| <b>Proj</b>  | <b>Figure</b>  |
|--------------|--|
|              | SUP00-3 Probabilistic calculation of geothermal energy reserves, Superstition Mountain, California   |
| <b>TRI00</b> | <b>Trinity Mountains District Telephone Well area</b>  |
|              | TRI00-1 Map showing hole locations and temperature data, Trinity District, Nevada  |
|              | TRI00-2 Map showing hole locations and temperature data in Telephone well area, Trinity District, Nevada   |
|              | TRI00-3 Probabilistic calculation of geothermal energy reserves, Telephone well area, Trinity District, Nevada                                     |
| <b>WAB00</b> | <b>Wabuska</b>   |
|              | WAB00-1 Map showing hole locations and temperature data, Wabuska Hot Springs, Nevada   |
|              | WAB00-2 Probabilistic calculation of geothermal energy reserves, Wabuska Hot Springs, Nevada   |
| <b>WES00</b> | <b>Westmorland</b>   |
|              | BRW00-1 Locations of geothermal areas of the Imperial Valley, California   |
|              | BRW00-2 Total depths and bottomhole temperatures of deep holes in the Salton Sea, Brawley and Westmorland areas of the Imperial Valley, California |
|              | WES00-1 Deep well data: Westmorland area, Imperial Valley, California  |
| <b>WIL00</b> | <b>Wilson Hot Springs</b>  |
|              | WIL00-1 Map showing hole locations and temperture data, Wilson Hot Springs, Nevada   |
|              | WIL00-2 Probabilistic calculation of geothermal energy reserves, Wilson Hot Springs, Nevada  |



**Appendix II**  
**Project Data Summary Report**  
**(example)**



**Hetch Hetchy/SFPUC Programmatic Renewable Energy Project**  
**Project: 1.3 New Geothermal Site Identification and Qualification**  
**Project Team: GeothermEx, Inc.**  
**Task: 1.3.10 Final Project Report**  
**Subject: D.1.3.10.3 Final Report**

**Appendix II:**  
**Project Data Summary**  
**Report (example)**

***Project Data Summary Report***

**PROJECT ID:** **BEO00**

**Project**

|   |                         |                         |  |                          |                                |
|---|-------------------------|-------------------------|--|--------------------------|--------------------------------|
| <b>PROJECT ID:</b>                        | <b>BEO00</b>            | <b>Area:</b>            | <b>1</b> <sup>(1)</sup>  | <b>MW installed:</b>     | <b>16.7</b> -gr <b>16</b> -net |
| <b>Name - District/Area/Field:</b>        | <b>Beowawe</b>          |                         |  | <b>MW produced (yr):</b> | <b>15 (1998)</b>               |
| <b>Name - Area / Power Plant:</b>         |                         |                         |  | <b>Plant Technology:</b> | <b>Dual Flash</b>              |
| <b>Exploration -Development Category:</b> | <b>A</b> <sup>(2)</sup> | <b>State:</b>           | <b>NV</b>  | <b>Lat:</b>              | <b>40.55</b>                   |
|   |                         | <b>Long:</b>            | <b>113.62</b>  | <b>Start Date (Yr):</b>  | <b>1985</b>                    |
| <b>Generation Capacity Estimated:</b>     | <b>Y</b>                | <b>County:</b>          | <b>Eureka-Lander</b>   |                          |                                |
|   |                         | <b>Owner:</b>           | <b>Caithness Energy, LLC</b>   |                          |                                |
|   |                         | <b>Developer:</b>       | <b>Chevron Resources Co.</b>   |                          |                                |
|   |                         | <b>Financier:</b>       |  |                          |                                |
|   |                         | <b>Operator:</b>        | <b>Caithness Operating Co., LLC</b>  |                          |                                |
|   |                         | <b>Notes - Project:</b> | Power plant design: GHCB, 20/2, 2001.<br>1) A portion of the KGRA is in Lander Co.<br>2) Power is sold to Southern California Edison via a wheeling agreement with Sierra Pacific Power Company.<br>3) MW net is also found listed as 13.0 |                          |                                |

**Government Funding**

1997? DOE grant to Idaho National Engineering Laboratory, Contract DE-AC07,94ID13223 (Fau97a)

**Landholding(s)** (Any landholdings listed are as represented by developers or lessees and have not been otherwise confirmed)

|                             |   |               |                                   |
|-----------------------------|---|---------------|-----------------------------------|
| <b>Property Name:</b>       |   |               |                                   |
| <b>Twn-Rng-Sec:</b>         | T31N, R47E, Section 24 and portions of Sections 13, 14 and 23<br>T31N, R48E, Section 18 and portions of Sections 7, 8, 17 and 19. |               |                                   |
| <b>Base &amp; Meridian:</b> | <b>Mt. Diablo</b>   | <b>Acres:</b> | <b>Owner Type:</b> <b>Private</b> |
| <b>Private Owner Name:</b>  | various   |               |                                   |
|                             | <b>Lease Obtained (Yr):</b>   |               | <b>Lease Expires (Yr):</b>        |
| <b>Comments:</b>            |   |               |                                   |

**Exploration / Development History**

| <b>Year</b> | <b>Exploration / Development Cost</b> | <b>Outcome/Comments</b>  |
|-------------|---------------------------------------|--|
| 1959-1960   | Drilling: 'full' diameter hole(s)     | Exploration drilling: Magma Power Company (Magma) drilled 2 wells in the vicinity of the sinter terrace, an area of fumaroles, hot springs and geysers in Section 17. Both were non-commercial.                          |
| 1960-1965   | Drilling: 'full' diameter hole(s)     | Discovery well: Magma drilled first productive well at Beowawe (Vulcan #1), located on top of the sinter terrace. Eleven other holes are drilled in the same general area; are some productive, some are non-commercial. |
| 1973-1975   | Geophysics: various                   | Chevron performed gravity, magnetic, seismic reflection, dipole-dipole resistivity, magnetotelluric, and self-potential surveys. Data entered public domain through the DOE Industry-Coupled Program (Swi79a).           |

|           |   |  |
|-----------|---|--|
| 1974      | Drilling: 'full' diameter hole(s)       | First deep productive well: Chevron drilled Ginn 1-13 to 9,563 feet and encountered deep production in a fractured interval associated with the down-dip extension of the Malpais Fault Zone (MFZ), at a location 1.1 miles SW of the sinter terrace area, in Section 13. Maximum temperature 420°F.                                       |
| 1974-1985 | Drilling: 'full' diameter hole(s)       | Development drilling: Chevron drilled 5 more full-sized wells along the MFZ. Three were productive (wells 33-17 (later abandoned), 85-18 (now an active injector), and Ginn 2-13). Two were non-commercial (wells Batz #1, Rossi 21-19). Another non-commercial full-sized well was drilled by Getty (Collins 76-17) southeast of the MFZ. |
| 1986      | Engineering: power plant on-line        | Power plant on-line: Chevron put plant on line with capacity of 16.7 MW (gross). Production from 2 wells (Ginn 1-13 and Ginn 2-13) and injection into a third (Batz #1, later switched to well 85-18).   |
| 1988      | Reservoir Engineering: field behavior   | Cooling trend begins: Plant output begins to decline, reaching 12.5 MW (gross) by early 1991 (Ben97a).   |
| 1991      | Drilling: 'full' diameter hole(s)       | Make-up well: Oxbow drilled a make-up well 77-13 and put it on line. Plant output initially recovered to full capacity, but decline in reservoir pressure accelerated (Ben97a).  |
| 1991      | Financial: project developer/owner      | Change of operator: Oxbow assumed operatorship of surface facilities at Beowawe.   |
| 1994      | Reservoir Engineering: field operations | Change injection strategy: Oxbow shifted injection from Batz #1 to 85-18. Reservoir pressure recovered to levels above those before 77-13 went on line, then leveled off (Ben97a).   |
| 1999      | Financial: project developer/owner      | Change of operator: Caithness bought out Oxbow's interest and became operator of the wellfield and the existing power plant.   |

## Well Summaries

| Well Type        | Self-Flowing Production   |                   | LogTypesAvail:   | T, lith, various others |             |
|------------------|---|-------------------|------------------|-------------------------|-------------|
| Number - total   |   |                   | Locations Avail? | yes                     |             |
| - active         | 3   |                   | Dev Svys Avail?  | yes                     |             |
| - standby        |   |                   |                  |                         |             |
|                  | Min.  | Max.              |                  | Min.                    | Max.        |
| TD               | 7000  | 9563 ft.          | SIWHP            |                         | psig        |
| CsgShoe depth    | 1787  | 2635 (Note 1) ft. | Flowing WHT      |                         | °F          |
| Csg ID           | 9-5/8   | 16 in.            | Flowing WHP      |                         | psig        |
| OH/Liner ID      | 7 bl  | 9-5/8 bl(N2) in.  | TD Rate          |                         |             |
| Perm Zone depth  | 6700  | 9600 ft.          | Water Rate       |                         | Rate units: |
| Perm Zone Temp   | 420   | 420 °F            | Steam Rate       |                         |             |
| BHT              | 420   | 420 °F            | Steam Pressure   |                         | psig        |
| Max-T            |   | 420 °F            | Enthalpy         |                         | btu/lb      |
| T Gradient (@TD) |   | °F / 100ft        | Capacity         |                         | 5 MWgr      |
| Inversions?      |   |                   | PumpType(s)      |                         |             |
| Closed Anomaly?  |   |                   | Pump Set Dpth    | ft.                     |             |
| Comments/ Notes  | Reservoir temperatures declined from an initial value of 420°F to a range of approximately 348° to 365°F (Ben97a)<br>1) in one hole, the liner is cemented to 7,857 ft, in another, liner is hung to about 9,500 ft (NVGEOWEL)<br>2) liners are hung (in one well, cemented), from casing shoe to the top of the permeable zone, which is open hole (NVGEOWEL)<br>3) 5 MWgr is average 15 MW/3 wells. |                   |                  |                         |             |

PROJECT ID: BEO00

|                         |  |             |
|-------------------------|--|-------------|
| <b>Well Type</b>        | <b>Injection</b>   |             |
| <b>Number - total</b>   | 2  |             |
| <b>- active</b>         | 1  |             |
| <b>- standby</b>        | 1  |             |
|                         | <b>Min.</b>  | <b>Max.</b> |
| <b>TD</b>               | 5927   | 6000 ft.    |
| <b>CsgShoe depth</b>    |  | ft.         |
| <b>Csg ID</b>           |  | in.         |
| <b>OH/Liner ID</b>      |  | in.         |
| <b>Perm Zone depth</b>  | 1500   | 1900 ft.    |
| <b>Perm Zone Temp</b>   | 125  | 355 °F      |
| <b>BHT</b>              | 255  | 320 °F      |
| <b>Max-T</b>            |  | °F          |
| <b>T Gradient (@TD)</b> |  | °F / 100ft  |
| <b>Inversions?</b>      |  |             |
| <b>Closed Anomaly?</b>  |  |             |
| <b>Comments/ Notes</b>  | Well 85-18; standby injector is Batz #1 (formerly used). Minimum and maximum temperatures are prior to long-term injection in Batz #1 and 85-18, respectively (Ben93a). Data also from NVGEOWEL. |             |

|                         |             |             |
|-------------------------|-------------|-------------|
| <b>LogTypesAvail:</b>   |             |             |
| <b>Locations Avail?</b> |             |             |
| <b>Dev Svys Avail?</b>  |             |             |
|                         | <b>Min.</b> | <b>Max.</b> |
| <b>SIWHP</b>            |             | psig        |
| <b>Flowing WHT</b>      |             | °F          |
| <b>Flowing WHP</b>      |             | psig        |
| <b>TD Rate</b>          |             |             |
| <b>Water Rate</b>       |             | Rate units: |
| <b>Steam Rate</b>       |             |             |
| <b>Steam Pressure</b>   |             | psig        |
| <b>Enthalpy</b>         |             | btu/lb      |
| <b>Capacity</b>         |             | MWgr        |
| <b>PumpType(s)</b>      |             |             |
| <b>Pump Set Dpth</b>    | ft.         |             |

|                         |   |             |
|-------------------------|---|-------------|
| <b>Well Type</b>        | <b>Observation</b>  |             |
| <b>Number - total</b>   |   |             |
| <b>- active</b>         | 1   |             |
| <b>- standby</b>        |   |             |
|                         | <b>Min.</b>   | <b>Max.</b> |
| <b>TD</b>               |   | 724 ft.     |
| <b>CsgShoe depth</b>    |   | 201 ft.     |
| <b>Csg ID</b>           |   | 10 in.      |
| <b>OH/Liner ID</b>      |   | 10 OH in.   |
| <b>Perm Zone depth</b>  |   | 600 ft.     |
| <b>Perm Zone Temp</b>   |   | 370 °F      |
| <b>BHT</b>              |   | 370 °F      |
| <b>Max-T</b>            |   | 370 °F      |
| <b>T Gradient (@TD)</b> |   | °F / 100ft  |
| <b>Inversions?</b>      |   |             |
| <b>Closed Anomaly?</b>  |   |             |
| <b>Comments/ Notes</b>  | Vulcan No.2. Data in NVGEOWEL, Ben93a; temperature profile in Ben93a. |             |

|                         |             |             |
|-------------------------|-------------|-------------|
| <b>LogTypesAvail:</b>   | T, lith     |             |
| <b>Locations Avail?</b> | yes         |             |
| <b>Dev Svys Avail?</b>  | yes         |             |
|                         | <b>Min.</b> | <b>Max.</b> |
| <b>SIWHP</b>            |             | psig        |
| <b>Flowing WHT</b>      |             | °F          |
| <b>Flowing WHP</b>      |             | psig        |
| <b>TD Rate</b>          |             |             |
| <b>Water Rate</b>       |             | Rate units: |
| <b>Steam Rate</b>       |             |             |
| <b>Steam Pressure</b>   |             | psig        |
| <b>Enthalpy</b>         |             | btu/lb      |
| <b>Capacity</b>         |             | MWgr        |
| <b>PumpType(s)</b>      |             |             |
| <b>Pump Set Dpth</b>    | ft.         |             |

|                       |                               |
|-----------------------|-------------------------------|
| <b>Well Type</b>      | <b>Full Diameter Expl/Dev</b> |
| <b>Number - total</b> | 13                            |
| <b>- active</b>       |                               |
| <b>- standby</b>      |                               |

|           |             |             |
|-----------|-------------|-------------|
|           | <b>Min.</b> | <b>Max.</b> |
| <b>TD</b> | 237         | 9005 ft.    |

|                         |  |  |
|-------------------------|--|--|
| <b>LogTypesAvail:</b>   |  |  |
| <b>Locations Avail?</b> |  |  |
| <b>Dev Svys Avail?</b>  |  |  |

|              |             |             |
|--------------|-------------|-------------|
|              | <b>Min.</b> | <b>Max.</b> |
| <b>SIWHP</b> |             | psig        |

|                         |  |                                 |                                 |   |
|-------------------------|--|---------------------------------|---------------------------------|---|
|                         |  |                                 | <b>PROJECT ID:</b> <b>BEO00</b> |   |
| <b>CsgShoe depth</b>    | <input type="text"/>   | <input type="text"/> ft.        | <b>Flowing WHT</b>              | <input type="text"/> °F                 |
| <b>Csg ID</b>           | <input type="text"/>   | <input type="text"/> in.        | <b>Flowing WHP</b>              | <input type="text"/> psig               |
| <b>OH/Liner ID</b>      | <input type="text"/>   | <input type="text"/> in.        | <b>TD Rate</b>                  | <input type="text"/>                    |
| <b>Perm Zone depth</b>  | <input type="text"/>   | <input type="text"/> ft.        | <b>Water Rate</b>               | <input type="text"/> <b>Rate units:</b> |
| <b>Perm Zone Temp</b>   | <input type="text"/>   | <input type="text"/> °F         | <b>Steam Rate</b>               | <input type="text"/>                    |
| <b>BHT</b>              | <input type="text"/>   | <input type="text"/> °F         | <b>Steam Pressure</b>           | <input type="text"/> psig               |
| <b>Max-T</b>            | <input type="text"/>   | <input type="text"/> °F         | <b>Enthalpy</b>                 | <input type="text"/> btu/lb             |
| <b>T Gradient (@TD)</b> | <input type="text"/>   | <input type="text"/> °F / 100ft | <b>Capacity</b>                 | <input type="text"/> MWgr               |
| <b>Inversions?</b>      | <input type="text"/>   |                                 | <b>PumpType(s)</b>              |   |
| <b>Closed Anomaly?</b>  | <input type="text"/>   |                                 | <b>Pump Set Dpth</b>            | <input type="text"/> ft.                |
| <b>Comments/Notes</b>   | Exploration and development holes drilled during 1959 - 1981 by Magma, Chevron, Getty. All in Section 17, most on the "sinter terrace" (hot spring area). Various outcomes (commercial producers, non-commercial). All but one have been abandoned (Rossi 21-19 is idle). (NVGEOWEL) |                                 |                                 |   |

## Reservoir Properties: Chemical

| <b>Dominant Phase:</b>   | <input type="text" value="LD"/>  |      |      |      |     |     |     |
|--------------------------|--|------|------|------|-----|-----|-----|
| <b>Fluid Composition</b> |  |      |      |      |     |     |     |
| <b>WaterType:</b>        | <input type="text" value="Na-HCO3"/>   |      |      |      |     |     |     |
|                          | <table border="1"> <thead> <tr> <th>Min.</th> <th>Max.</th> <th>Avg.</th> </tr> </thead> <tbody> <tr> <td>890</td> <td>920</td> <td>910</td> </tr> </tbody> </table> | Min. | Max. | Avg. | 890 | 920 | 910 |
| Min.                     | Max.   | Avg. |      |      |     |     |     |
| 890                      | 920  | 910  |      |      |     |     |     |
| <b>TDS-Total Disch:</b>  | ppm-wt   |      |      |      |     |     |     |
| <b>TDS-Sep. Water:</b>   | ppm-wt   |      |      |      |     |     |     |
| <b>GasType:</b>          | <input type="text"/>   |      |      |      |     |     |     |
|                          | <table border="1"> <thead> <tr> <th>Min.</th> <th>Max.</th> <th>Avg.</th> </tr> </thead> <tbody> <tr> <td></td> <td></td> <td></td> </tr> </tbody> </table>          | Min. | Max. | Avg. |     |     |     |
| Min.                     | Max.   | Avg. |      |      |     |     |     |
|                          |  |      |      |      |     |     |     |
| <b>Gas/Steam:</b>        | ppm-wt   |      |      |      |     |     |     |
| <b>Gas/Total Disch:</b>  | ppm-wt   |      |      |      |     |     |     |
| <b>Comments</b>          |  |      |      |      |     |     |     |

Minimum and maximum TDS values are from Ginn 2-13 and Ginn 1-13, respectively (Ben93a). Range of Cl among 6 samples (4 boiling hot springs and 2 boiling wells) is 30 - 70 mg/l (GEOTHERM)

|   |                                  |                                  |                                     |
|---|----------------------------------|----------------------------------|-------------------------------------|
| <b>Chemical Geothermometers</b>   |                                  |                                  |                                     |
|   | <b>Min.</b>                      | <b>Max.</b>                      | <b>Avg.</b>                         |
| <b>Quartz:</b>  | <input type="text" value="390"/> | <input type="text" value="454"/> | <input type="text" value="427"/> °F |
| <b>Chalcedony:</b>  | <input type="text" value="363"/> | <input type="text" value="432"/> | <input type="text" value="403"/> °F |
| <b>Na-K-Ca:</b>   | <input type="text" value="385"/> | <input type="text" value="470"/> | <input type="text" value="430"/> °F |
| <b>Na-K-Ca-Mg:</b>  | <input type="text" value="381"/> | <input type="text" value="466"/> | <input type="text" value="426"/> °F |
| <b>K-Mg:</b>  | <input type="text"/>             | <input type="text"/>             | <input type="text"/> °F             |
| <b>SO4-H2O Iso.:</b>  | <input type="text"/>             | <input type="text"/>             | <input type="text" value="484"/> °F |
| <b>Comments</b>   |                                  |                                  |                                     |
| Ranges and averages among 6 samples (4 boiling hot springs and 2 boiling wells).<br>Adiabatic corrections have been applied to the silica temperatures. Mg at 0.1 to 0.2 mg/l (GEOTHERM). SO4-H2O isotope temperature from USGSOF79-1135. |                                  |                                  |                                     |

## Reservoir Properties: Physical

|                         |                                   |                                    |                                   |                 |   |
|-------------------------|-----------------------------------|------------------------------------|-----------------------------------|-----------------|---|
| <b>AVERAGE</b>          | <b>Min.</b>                       | <b>Max.</b>                        | <b>MLk.</b>                       |                 | <b>Comments</b>   |
| <b>Temperature:</b>     | <input type="text" value="400"/>  | <input type="text" value="420"/>   | <input type="text" value="410"/>  | °F              | Max is at the permeable zones of the production wells. Min is suggested by the chalcedony temperature. MLk is the average.  |
| <b>Depth to Top:</b>    | <input type="text" value="6000"/> | <input type="text" value="7000"/>  | <input type="text" value="6500"/> | ft.             | Temperature model (Figure BEO00-2) suggests that the reservoir above about 6,500 ft is confined to a very narrow zone within the Malpais fault. Uppermost major permeability is at c.6,700 ft. Min and Max represent uncertainty.   |
| <b>Thickness:</b>       | <input type="text" value="3100"/> | <input type="text" value="4100"/>  | <input type="text" value="3600"/> | ft.             | Thicknesses from top to 10,100 ft (deepest production plus 500 ft)  |
| <b>Area:</b>            | <input type="text" value="2.0"/>  | <input type="text" value="3.0"/>   | <input type="text" value="2.5"/>  | mi <sup>2</sup> | Mlk is based on a high temperature area of about 3 square miles at 10,000 ft (Figure BEO00-2), adjusted downwards for cooler conditions and more limited area at higher levels particularly at the NE end. Min and Max represent an uncertainty of +/-0.5 mi <sup>2</sup> . |
| <b>Porosity:</b>        | <input type="text" value="3.0"/>  | <input type="text" value="7.0"/>   | <input type="text"/>              | %               | Standard values   |
| <b>Recovery Factor:</b> | <input type="text" value="5.00"/> | <input type="text" value="20.00"/> | <input type="text"/>              |                 |   |
| <b>Rejection Temp:</b>  | <input type="text"/>              | <input type="text"/>               | <input type="text" value="59"/>   | °F              |   |

Setting/Lithology: \_\_\_\_\_

## Operational Constraints

| <u>Constraint</u> | <u>Description</u> |
|-------------------|--------------------|
|                   |                    |

## Estimated Generation Capacity

### MW for 30 years

| Minimum<br>(90%<br>probable) | Most-Likely<br>(modal) | Mean | Standard<br>Deviation |
|------------------------------|------------------------|------|-----------------------|
| 30                           | 41                     | 58   | 21                    |

### Comments/Notes

Figure BEO00-3. Based on relatively good and complete data. Estimate does not include heat reserves in the discharge (upflow) zone to the hot springs area (above a depth of about 6,500 ft), but the temperature model (Figure BEO00-2) suggests that the volume of this zone is quite small relative to deeper reserves. The histogram of estimated values has a broad maximum, which makes the most-likely value relatively non-unique.

## Figures

| Number  | Name   |
|---------|--|
| BEO00-1 | Well location map, Beowawe geothermal field                              |
| BEO00-2 | Beowawe initial-state temperatures within Malpais fault zone             |
| BEO00-3 | Probabilistic calculation of geothermal energy reserves, Beowawe, Nevada |

### (1) Geographic Areas:

Area 1 – Greater Reno, Nevada (includes California locations)

Area 2 – Nevada sites with direct access to the California grid

Area 3 – Other Nevada locations

Area 4 – All other California

### (2) Exploration-Development Categories:

A – Existing power plant operating

B – One or more wells tested at  $\geq 1$  MW (no power plant in operation)

C – Minimum 212°F logged downhole (no well tests at  $\geq 1$  MW)

D – Other exploration data and information available ( $\geq 212^\circ\text{F}$  not proven)

No category assigned – area does not meet the minimum criteria (see Final Report section 2.2)



**Appendix III**  
**Methodology of Estimating Generation Capacities**  
**(Geothermal Energy Reserves)**



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## **APPENDIX III**

### **METHODOLOGY OF ESTIMATING GENERATION CAPACITIES (GEOTHERMAL ENERGY RESERVES)**

#### **1. THEORETICAL BASIS OF THE ESTIMATION METHOD**

##### **1.1 Introduction**

To estimate energy reserves in the various project areas, we have used a methodology that has been used by GeothermEx over the past two decades. This methodology is a volumetric reserve estimation approach introduced by the U.S. Geological Survey (ref: USGSC790), modified to account for uncertainties in some input parameters by using a probabilistic basis (Monte Carlo simulation).

This technique to estimate reserves is based on a volumetric calculation of the heat-in-place at each project area, with reasonable assumptions made about:

- the percentage of that heat that can be expected to be recovered at the surface; and
- the efficiency of converting that heat to electrical energy.

As explained below, the heat-in-place calculation takes into account only a volume of rock and water that is reasonably likely to contain adequate permeability and temperature for the generation of electricity using contemporary technology. Hot rock that is deeper than likely to be economically drillable in a contemporary commercial project is not included.

The term “reserves” as used herein is analogous to the “geothermal reserve(s)” of USGSC790 (p.4), and different from the overall “geothermal resource,” which includes all heat underground. In USGSC790 the concept of “resource” is further subdivided into “inaccessible” (very deep) and “accessible” (likely to be drillable in the ‘foreseeable’ future), and “accessible” resource is further subdivided into “residual” (too deep for present economics) and “useful” (perhaps drillable at currently acceptable cost). Finally “useful” is subdivided into “subeconomic” (probably too deep, especially if the resource temperature is not very high, or displaying inadequate permeability), and “economic” (considered likely to be viable).

In USGSC790 (p.4) the term “geothermal reserve” is defined as “that part of the geothermal resource that is identified and also can be extracted legally at a cost competitive with other commercial energy sources at present.” It must be emphasized that an estimate of reserves using the volumetric method does not imply any guarantee that a given level of power generation can be achieved. Before a given level of generation can be realized, wells capable of extracting the heat from the rock by commercial production of geothermal fluid must be drilled and tested. This is the only

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way to unequivocally establish the presence of commercially viable reserves and demonstrate the desired generating capacity of each locally defined resource.

## 1.2 Calculation of Generation Capacity

In the GeothermEx method, the maximum sustainable generation (power plant) capacity (E) is given by:

$$E = V C_v(T-T_o) \cdot R/F/L \quad (1.1)$$

where  $V$  = volume of the reservoir,

$C_v$  = volumetric specific heat of the reservoir,

$T$  = average temperature of the reservoir,

$T_o$  = rejection temperature (equivalent to the average annual ambient temperature),

$R$  = overall recovery efficiency (the fraction of thermal energy in-place in the reservoir that is converted to electrical energy at the power plant),

$F$  = power plant capacity factor (the fraction of time the plant produces power on an annual basis), and

$L$  = power plant life.

The parameter  $R$  can be determined as follows:

$$R = \frac{W \cdot r \cdot e}{C_f \cdot (T - T_o)} \quad (1.2)$$

where  $r$  = recovery factor (the fraction of thermal energy in-place that is recoverable as thermal energy at the surface),

$C_f$  = specific heat of reservoir fluid,

$W$  = maximum available thermodynamic work from the produced fluid, and

$e$  = utilization factor to account for mechanical and other losses that occur in a real power cycle.

The parameter  $C_v$  in (1.1) is given by:

$$C_v = \rho_r C_r (1-\phi) + \rho_f C_f \phi \quad (1.3)$$

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where  $\rho_r$  = density of rock matrix,

$C_r$  = specific heat of rock matrix,

$\rho_f$  = density of reservoir fluid, and

$\phi$  = reservoir porosity.

The parameter W in (1.2) is derived from the First and Second Laws of Thermodynamics as follows:

$$dW = dq (1 - T_o / T) \quad (1.4)$$

and

$$dq = C_r dT \quad (1.5)$$

where q represents thermal energy and T represents absolute temperature.

## 2. ASSIGNMENT OF PARAMETERS FOR GENERATION ESTIMATES

In the Monte Carlo simulation method of calculating reserves, some parameters in equations 1.1 to 1.3 are assigned fixed values, and others are assigned ranges of values believed to be likely, on the basis of available information about the resource. These ranges may include only a minimum (Min) and a maximum (Max), or may also include a most-likely (Mlk) value.

The Monte Carlo method proceeds by calculating a large number of generation estimates (for this project, 10,000 estimates). Each time the calculation is done, each uncertain parameter is assigned a random value within the span of Min and Max, or a random value within a triangular probability distribution that is defined by Min, Mlk and Max. The results of the multiple generation estimates are then compiled to obtain an overall Minimum Generation Capacity Estimate (here defined as the capacity value with a cumulative probability of more than 90%; i.e. 90% of estimates will be equal to or greater than this value), and a Most-likely Generation Capacity Estimate (here defined as the modal generation capacity; i.e. the most-frequently estimated value). The mean (average) of the estimated values is also recorded, as well as the standard deviation of the mean.

### 2.1 Parameters Assigned a Statistical Uncertainty

#### 2.1.1 Reservoir Temperature (T)

If there is deep drilling, testing and/or production data, this information is used to estimate minimum, maximum and most-likely average temperatures for the hydrothermal system within the likely reservoir volume. There is a certain amount of feed-back

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between this process and the process of defining the thickness and area of the reservoir, to insure that the temperature values and volumetric parameters are compatible.

If the amount of down-hole temperature information is limited (usually the case if there is no developed geothermal field), then temperature estimates are chosen from the chemical and isotope geothermometers and from such drilling data as may be available. In most cases, the geothermometers provide at least two temperature estimates: the maximum temperature that is likely to be present in the hydrothermal system, and a minimum temperature that reflects the latest full or partial chemical equilibration between hot water and hot rock, usually in the shallowest part of the hydrothermal system. A most-likely average temperature is estimated from the minimum and maximum, from a third chemical temperature if suitable, or from drilling data. Explanations for the choice of minimum, maximum and most-likely average temperature are included with the reservoir physical properties of each project area.

Prospect areas where there are no deep drilling data and no chemical data (the thermal anomaly is blind and/or there are no chemical data) present a special problem for both the thickness of the reservoir (as discussed below) and for temperature. In all such cases there is a thermal anomaly that is indicated by shallow temperature gradient drilling (generally to 300 or 500 ft), and sometimes also by ID (Intermediate-Depth) slim-hole drilling (to about 2,000 ft). Elevated gradients in multiple holes can establish the approximate surface area of an anomaly (see more below), but otherwise they indicate only the rate of temperature increase moving downwards. Temperature gradients do not indicate at what (greater) depth and temperature a reservoir is present.

In these cases:

- If there is some indication that a hot aquifer has been reached in some holes, and a likely minimum temperature can be inferred, then that temperature is used as the minimum average (such as 250°F at the Aurora, Nevada, project AUR00). If there are insufficient data to indicate even a likely minimum temperature, then the default minimum average temperature that is used is 225°F, which is the lowest average production zone temperature at 11 geothermal fields in Nevada, with no known or suspected volcanic heat source, that are actually in commercial production or extensively drilled (part A of Table III-1<sup>1</sup>; Wabuska project).
- The default maximum average that is assigned is 440°F, which is the highest average permeable zone temperature at the same set of 11 geothermal fields (part A of Table III-1; Dixie Valley project).

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<sup>1</sup> Temperatures from Table III-1 are herein rounded to the nearest 5°F.

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- The default most-likely average reservoir temperature that is assigned is 345°F, which is the average of the 11 geothermal fields (part A of Table III-1).

In all of these cases we have based the averages on well-known fields without volcanic heat sources because few, if any, of the new fields being estimated are likely to have a volcanic heat source. Exceptions are handled as individual cases.

### **2.1.2 Reservoir Thickness (factor of V)**

Reservoir volume (see Section 1.2 of this appendix) is calculated as the product of reservoir thickness and reservoir area, which are each separately assigned a statistical uncertainty. The database of geothermal project areas also includes (among reservoir properties) the depth to top of reservoir. This parameter is not used for the actual reserves calculation, but it is documented because it provides a guideline for required minimum drilling depths.

The top, bottom and corresponding thickness of the reservoir (all assumed to be average values) are based on drilling data if available. Typically, the thickness value is adjusted by adding 500 ft, to allow for the probability that the deepest permeable zones reached by drilling will be mining the heat and fluid from another 500 ft below<sup>2</sup>. This adjustment may be omitted, however, if there is evidence that the commercial reservoir zone overlies a temperature inversion.

Often, the top is reasonably well-established but the bottom is uncertain because deeper drilling has not been done at all, or has not been done in enough wells to support a very confident estimate.

If the depth to bottom or depths to both top and bottom are unknown, then default average thickness values are applied, based on the thicknesses of permeable intervals in the 11 geothermal fields of Table III-1: the minimum permeable thickness is 2000 ft, the maximum is 5,000 ft, and the average is 3,000 ft. As with the data from drilling, these values are adjusted by adding 500 ft, to allow for the probability that heat and some fluid can be mined from below the principal zone of permeability. Therefore, the minimum reservoir thickness that is assigned is 2,500 ft (0.8 km), the maximum reservoir thickness that is assigned is 5,500 ft (1.7 km), and the adjusted average, 3,500 ft (1.1 km) is used for the most-likely value.

Corresponding thicknesses in Circular 790 were 30% to 50% greater (1 km, 2.5 km and 1.5 km). The more conservative thickness values used herein are justified by three

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<sup>2</sup> This 500 ft interval is seen as an integral part of the “reservoir” and of the initial “reserves,” and is not a “recharge” or “resupply” increment, since thermal recharge (or resupply) is not included in the heat-in-place calculation.

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observations. First, they are supported by the data in Table III-1 (largely obtained since 1979). Second, most field developments since 1979 have succeeded in developing only a fraction of the reserves estimated in Circular 790. Third, drilling costs have a practical limit on the commercial viability of development, particularly for moderate-temperature resources. In Circular 790 the heat reserves were calculated to a standard depth of 3 km (9,800 ft), but this depth is likely to exceed the limits of practical commercial viability for heat extraction if the resource temperature is less than the average 345°F.

#### 2.1.3 Reservoir Area (factor of V)

If there is actual evidence concerning the reservoir area, from temperature contours based on deep well logs or from temperature gradients in shallower wells, this information is used to pick the minimum, maximum and most-likely areas. Hot spring locations and temperatures are used to guide the estimates, knowing, however, that a hot spring represents the outflow from a hydrothermal system which may be horizontally displaced from the principal area of the deep reservoir, at distances of several miles or more.

If downhole information is very limited, and the existence of a reservoir is implied only by the presence of a hot spring, then the most-likely area is considered to be 0.8 square miles, which is very close to a circle of one-half mile radius (0.79 square miles or 2.03 square km). The minimum is taken as one-half of this, or 0.4 square miles (1.04 sq km), and the maximum assigned area is 1.2 square miles (3.11 sq km). These values are nearly equal to the 1, 2 and 3 square km areas assigned in Circular 790.

It is reasonable to relate the minimum, most-likely and maximum areas using simple multiples of the minimum area (1, 2 and 3), instead of expanding the radius of a minimum circle by some multiple, because most geothermal reservoirs that are heated by deep circulation in a tectonic regime (the dominant type in Nevada) tend to be elongated in one direction, rather than circular in shape. Sometimes the elongation is extreme, as at Empire (San Emidio), Nevada (project EMP00). In fact, the real shape of the default most-likely area of 0.8 square miles is likely to be closer to a rectangle or elongate oval, with an aspect ratio somewhere between 5:1 and 1.5:1, than to a circle.

In areas where two or more hot springs or wells are present and it is believed that a continuous reservoir volume or heat anomaly is likely to connect them, but the boundaries of the thermal anomaly remain uncertain, the most-likely value is the area encompassed by the springs and wells to a distance of 0.5 mile radius around the outer-most points<sup>3</sup>. The minimum area is one-half of the most-likely area, and the maximum is 1.5 times the most-likely area.

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<sup>3</sup> For example, if two points are separated by 2 miles, then the most-likely area is calculated as a rectangle with rounded corners ( $r = 0.5$  mile) that is three miles long ( $0.5 + 2.0 + 0.5$ ) and one mile wide ( $0.5 + 0.5$ ), or 3 square miles, minus 0.05 square mile at each corner. The total area is thus 2.8 square miles.

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#### 2.1.4 Porosity ( $\phi$ )

Unless there is a compelling reason to apply other values, a default minimum porosity of 3.0% and a default maximum porosity of 7.0% are used, without a most-likely value. Reservoirs known or likely to reside in sedimentary rocks with significant inter-granular porosity (as in the Imperial Valley of California) are assigned a range of 10% to 20%. Porosity has very little effect on the overall outcome of the generation capacity estimate, because it represents only the small fraction of the overall reservoir volume that is occupied by water instead of rock. Water has a smaller heat capacity than rock, so a higher porosity translates into less heat in place.

#### 2.1.5 Recovery Factor ( $r$ )

In Circular 790, the U.S.G.S. used a recovery factor of 0.25 for reserves estimates of individual hydrothermal convection systems. Based on our assessment of more than 100 geothermal sites around the world, we have found it more realistic to apply a recovery factor in the range of 0.05 (Min) to 0.2 (Max) without application of a most-likely value. These values are assigned herein as default values. For a specific site that is reasonably well-known, this range is adjusted based on an integrated analysis of the available exploration, drill and production data. For example, at the reservoirs in sedimentary rocks of the Imperial Valley of California the Min value is adjusted to 0.10 (Min), because the reservoir fluids in these sedimentary systems are considered less likely than elsewhere to short-circuit through specific fractures.

### 2.2 Parameters Assigned a Fixed Value

#### 2.2.1 Rock Volumetric Heat Capacity ( $C_r$ )

A default average value of 39 BTU/cu.ft °F (2,613 kJ/m<sup>3</sup>°C) is used, based on data for heat capacities in a variety of rocks at 350°F in Prats, 1982 (Pra82a) and an average crustal density of 168.6 lb/cu.ft (2.7 gm/cc). The heat capacity used herein is slightly lower than the value of 2,700 kJ/m<sup>3</sup>°C (c.40 BTU/cu.ft °F) used in Circular 790. Differences of heat capacity between different types of well-consolidated rock are fairly small, and much smaller than other uncertainties in the generation estimate.

#### 2.2.2 Rejection Temperature ( $T_0$ )

A default value of 59°F (15°C) is applied, unless there is specific knowledge of the local mean annual air temperature.

#### 2.2.3 Utilization Factor ( $e$ )

Utilization factor ( $e$ ) represents the efficiency of power generation at a given power plant in converting theoretically available work to actual electrical energy. The value of  $e$  can

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vary considerably, from about 0.2 to about 0.5, depending on many factors that include the efficiency of the basic power plant design, the resource temperature, the concentration of dissolved gases in the reservoir fluid, and the condition of plant maintenance. For example, the value of an air-cooled binary plant will be lower than a water-cooled binary plant. The exact efficiency of a given plant is often difficult to determine without a detailed knowledge of historical plant and resource performance, and the efficiency of a proposed plant (not yet in operation) is subject to the claims of manufacturers and designers that may be less than fully documented. In addition, the efficiency of a plant may change with time during operations. General examples are included in Circular 790.

Because of these uncertainties, a default value of  $e$  is applied. Circular 790 used a value of 0.4, but we believe that advances in plant efficiency since the publication of Circular 790 justify a default value of 0.45, which is used herein.

### **2.2.4 Plant Capacity Factor (F)**

A value of 0.90 is used, which is reasonably typical of modern geothermal plants that are well-maintained and operated.

### **2.2.5 Power plant life (L)**

All cases herein assume a power plant (and project) life of 30 years.

**Table III-1: Physical characteristics of producing geothermal fields**

| A. Areas with no volcanic heat source |  | Depths of Major Permeable |       | Thickness(ft) <sup>2</sup> | Temperature (°F) (initial conditions) |     |                  |  |
|---------------------------------------|--|---------------------------|-------|----------------------------|---------------------------------------|-----|------------------|--|
| Project ID                            | Name                                   | min                       | max   |                            | min                                   | max | avg <sup>3</sup> |  |
| BEO00                                 | Beowawe                                | 6700                      | 9600  | 2900                       | 420                                   | 420 | 420              | Excludes shallower and narrower outflow zone to hot spring area  |
| BRA00                                 | Brady's Hot Springs                    | 1000                      | 5500  | 4500                       | 340                                   | 390 | 365              | Excludes shallow, cooler injection area to the north             |
| DES00                                 | Desert Peak                            | 2500                      | 4200  | 1700                       | 390                                   | 419 | 405              |  |
| DIX00                                 | Dixie Valley                           | 5600                      | 9500  | 3900                       | 402                                   | 478 | 440              |  |
| EMP00                                 | Empire                                 | 1700                      | 3700  | 2000                       | 305                                   | 306 | 306              | Max assumed 2000 ft below Min (no deep drilling in central zone) |
| FIS00                                 | Fish Lake Valley                       | 5000                      | 10000 | 5000                       | 360                                   | 390 | 375              | Not yet producing but conditions reasonably well-defined         |
| HON01-03                              | Honey Lake - all projects              | 1300                      | 5300  | 4000                       | 223                                   | 250 | 237              |  |
| RYE01                                 | Rye Patch - Humb. District (Rye Patch) | 1900                      | 4000  | 2100                       | 260                                   | 405 | 333              | Not yet producing but conditions reasonably well-defined         |
| SOD00                                 | Soda Lake                              | 1000                      | 4000  | 3000                       | 360                                   | 375 | 368              |  |
| STI01-02                              | Stillwater                             | 1000                      | 3000  | 2000                       | 320                                   | 360 | 340              |  |
| WAB00                                 | Wabuska                                | 2000                      | 4000  | 2000                       | 220                                   | 227 | 224              | Max assumed 2000 ft below Min (no deep drilling done)            |
| Average of 11 resources               |  | 2700                      | 5709  | 3009                       | 327                                   | 365 | 346              |  |
| Standard Deviation                    |  | 1966                      | 2532  | 1111                       | 66                                    | 72  | 66               |  |
| Median                                |  |                           |       | 2900                       |                                       |     | 365              |  |

| B. Areas with identified or possible volcanic heat source |   |     |     | Production Zone                       |     |     |     |
|---|---|-----|-----|---------------------------------------|-----|-----|-----|
| Project ID  | Name  |     |     | Temperature (°F) (initial conditions) |     |     |     |
|   |   | min | max | avg                                   |     |     |     |
| COS00   | Coso  |     |     |                                       | 392 | 650 | 521 |
| LVC00   | Long Valley - Casa Diablo (Mammoth Pacific Field) |     |     |                                       | 320 | 355 | 338 |
| STE01-03  | Steamboat H.S. - all Lower Steamboat projects     |     |     |                                       | 320 | 340 | 330 |
| STE04   | Steamboat H.S. - Yankee/Caithness project         |     |     |                                       | 434 | 480 | 457 |

1. Production zones and permeable hot injection zones (significantly shallower or cooler injection zones not included).
2. This thickness is the simple difference between min and max depth and may not be equal to the most-likely reservoir average thickness used in the calculation of the project's estimated generation capacity.
3. This average is the simple mean between the min and max and may not be equal to the most-likely reservoir average temperature used in the calculation of the project's estimated generation capacity.



**Appendix IV**  
**Methodology of Estimating Exploration and Confirmation Costs**



**APPENDIX IV**

**METHODOLOGY OF ESTIMATING  
EXPLORATION AND CONFIRMATION COSTS**

**1. INTRODUCTION**

Exploration and confirmation costs are estimated for every geothermal project in the database that has a corresponding estimation of generation capacity.

**1.1. Exploration Background**

In the context of this study, exploration encompasses all activities up to and including the site selection for drilling either: A) the first deep, full-diameter confirmation well (projects in Exploration-Development Category C or D) or; B) a first additional production well (projects in Exploration-Development Category A or B). In some other contexts, the first well might be termed an “exploration well,” but herein, all deep, full-diameter drilling is part of confirmation and development.

An exploration cost estimate is not made if a project area is considered adequately explored to enable a well to be sited. This includes most Category A projects, and some Category B projects. “Adequately explored” means that exploration has been carried out and the data and information obtained are likely to be available in some combination of the public and private domains.

There are numerous Category B to D projects which have explored by private developers, but for which the amount and quality of past exploration (including adequate documentation) remains relatively uncertain because much of the information remains in private hands. In such cases, we have chosen to estimate that new exploration work must be done. Although privately held exploration data may be available for purchase, we have not attempted to estimate such purchasing costs, but rather estimate the costs of a new exploration program.

The program components and unit costs of the estimated exploration projects are discussed below.

**1.2. Confirmation Background**

In the context of this study, confirmation comprises successfully demonstrating, at the wellhead, 25% of the previously unconfirmed but estimated overall generation capacity of the resource. This is done by drilling and testing deep, full-diameter wells designed for production.

Based on GeothermEx’s experience, 25% is about the amount of proven wellhead capacity that is likely to be required by a bank before it will provide credit for complete field development and power plant design and construction. (Some banks may require

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higher or lower percentages based on field-specific risk factors.) In estimating the confirmation costs, it is assumed that a certain percentage of holes drilled will not be successful producers (the dry hole fraction; see below), and a reservoir study that confirms the likely total capacity is also included.

Lender's likely requirements for injection capacity are typically less predictable than requirements for production capacity, but injection capacity is considered, particularly when only one production confirmation well is expected to be required. In such cases, it is usually estimated that a second well must be drilled, unless there are existing holes that might be used for reservoir- and well-testing purposes. In some cases, "existing holes" may include ID (Intermediate-Depth) slim holes (see below) drilled already or planned during exploration.

Confirmation costs are estimated for both the Minimum (Min) Generation Capacity Estimate (Monte-Carlo 90% probability) and Most-Likely (Mlk) Generation Capacity Estimate (Monte-Carlo modal estimate). For some Category A projects the Min Capacity Estimate is smaller than current production, and in such cases no confirmation cost is estimated for that Capacity value.

## **2. PROGRAM COMPONENTS AND UNIT COSTS**

The exploration and confirmation program components and unit costs for each component are listed and described in Table IV-1. The unit costs listed therein are used as a starting point for program cost estimation. To accommodate differences among the various geothermal projects, all exploration unit costs and some confirmation unit costs may be adjusted within a particular cost estimate, by applying cost adjustment factors (Appendix V is an example).

### **2.1. Exploration Program Components**

The exploration program components (Table IV-1) are those considered to be most likely useful for evaluating the resource, constructing a conceptual model, and siting a confirmation well.

By far, the most expensive exploration component is ID slim-hole drilling. In the context of exploration costs this refers to a hole that is drilled to approximately 2,000 ft (occasionally less), which is not designed for commercial production, but which is drilled with blowout prevention equipment and designed with casing to stabilize the hole to permit injection testing and (in a few instances) limited production testing<sup>1</sup>. Such a hole is typically drilled to obtain a combination of information on geology, temperature and

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<sup>1</sup> This definition is somewhat more restricted than the definition applied to ID slim hole within the database of resource characteristics (see Final Report chapter 7 (Glossary) and the Abbreviations & Definitions button on the Projects screen of the PRP Geothermal Database).

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permeability. The cost of testing an ID slim hole is included in the exploration program when it is deemed reasonably likely that permeability will be encountered at a commercially interesting temperature.

The estimated basic unit (per foot) cost of drilling an ID slim hole is about 10 times that of drilling a simple temperature gradient hole (restricted in the exploration programs to 500 ft), and about one-half the cost of drilling a full-diameter production hole. Because ID slim holes are relatively expensive yet cannot be used for commercial production, there has been little consistency in the historic use of ID slim-hole drilling. Some developers have chosen to skip ID slim holes entirely, and proceed directly to full-diameter drilling. The historic trend of geothermal exploration has been to increasingly include ID slim holes, as a way to reduce initial exploration/confirmation risk at the potential expense of higher eventual overall cost, so the bias herein is to include ID slim holes in the exploration programs.

The second most expensive exploration component is a magneto-telluric (MT) or direct-current (DC) resistivity survey. It has been GeothermEx's experience that these surveys have mixed success in aiding the siting of ID slim holes and deep full-diameter holes at the small- to moderate-sized resources of Nevada and California (greater success has been found at larger resources hosted by young volcanic systems). Accordingly, these surveys are included in only a few projects, where there is already a relatively confident indication of high temperature and generation capacity, which reduces the risk associated with the substantial expense of this geophysical method.

### **2.2. Confirmation Program Components**

The confirmation program is basically a combination of deep, full-diameter drilling with testing, reporting, administration and regulatory costs (see Table IV-1).

Total drilling costs for confirmation are estimated using the formula that relates well cost to total well depth (Table IV-1 and Final Report section 3.3). This cost includes road and pad construction, mobilization, drilling, mud logging, temperature logging, geophysical logging and a short flow or injection test with the drilling rig still on the hole (rig test).

Total drilling cost is thus a product of (cost/depth) times (average depth/well) times (expected total number of wells required):

1. Average depth/well is calculated as the sum: (most-likely average depth to top of reservoir) + (most-likely average reservoir thickness) – 500 ft. These thicknesses are included in the reservoir physical properties section of the PRP Geothermal Database.

If a project's most-likely (Mlk) value is not listed, then the average of minimum (Min) and maximum (Max) values is used. It should be noted that this estimate provides for drilling to nearly the bottom of the reservoir, and some wells will be

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successful at shallower depths. A lesser thickness is not used for cost estimation because many wells need to penetrate multiple permeable zones, and some wells may be shallower, but deviated. When depth-to-top is unknown, a default value of 2700 ft is substituted: this is the average depth to uppermost permeability among 11 geothermal systems in Nevada<sup>2</sup>.

### **2. Expected total number of wells is a function of:**

- a. MW sought (size of project). This is equal to the Estimated Generation Capacity (the Monte-Carlo Min or Monte-Carlo Mlk value) minus any existing generation capacity (MW currently being produced).
- b. Expected MW/well. This is calculated from average reservoir temperature and well productivity (MW) as a function of temperature (see Final Report section 3.3.2 and Table IV-1).

Average temperature is the Mlk estimated average value if one is listed under reservoir physical properties. Otherwise, the average of Min and Max estimated average temperatures is used. If a given project is likely to have a different MW/well value, an adjustment is made using the drilling cost factor.

- c. A standard unsuccessful hole factor of 40% (60% of confirmation holes successful as commercially viable production wells; 40% dry or otherwise unsuccessful). See below and Table IV-1.
- d. The requirement (described above) that 25% of the wellhead power capacity sought be confirmed by successful drilling. At a few projects some of this capacity has already been confirmed (successful production wells drilled but not in use).

The unsuccessful hole factor is a parameter that is difficult to predict for any individual project. Historical experience at geothermal projects in California and Nevada has included a very wide range of unsuccessful hole factors, which has varied partly in relation to the difficulty of finding adequate permeability and/or temperature at depth, and partly in relation to historical context. At many projects that were started in the 1960s and 1970s there was a considerable amount of drilling that was done with limited geothermal drilling experience and relatively little geotechnical support for well siting. Some of the wells drilled were unsuccessful, and in some cases this was due to lack of drilling experience. Other

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<sup>2</sup> See Appendix III, Table III-1. The Nevada average is used because the project areas that need assignment of a default value are all in Nevada (with one exception: Superstition Mountain in the Imperial Valley of California).

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holes, although successful, were never used because the binary technology needed to exploit moderate temperature resources was not yet available. Accordingly, many of these holes were eventually abandoned unused, and many would not be drilled in the context of a project started in year 2003. Reasons for abandonment are not always clear, and it is not possible to simply ignore all of the early drilling experience, because the results of these early holes helped to guide the siting of subsequent holes.

To approach the question of an appropriate unsuccessful hole factor, we have compiled historical drilling information from the public domain into Table IV-2 (Totals of full-diameter, production and injection wells at geothermal projects in California and Nevada). These data show that if the sum of total available (active and idle) production (P) and injection (I) wells at a project is divided by the number of full-sized wells drilled (T), the result  $(P+I)/T$  has ranged from about 0.3 to 1.0, and the historical average  $(P+I)/T$  is about 0.65. When experience is considered and the total T is adjusted to a best estimate for each project if developed in year 2003, the adjusted  $(P+I)/T$  becomes 0.5 to 1.0, with an average of about 0.8.

This suggests that about 80% of all holes drilled will be successful as production or injection wells, and 20% will not be successful. A separate value for production wells only has not been estimated in Table IV-2, because there is no way (without much more detailed information) to know which injection wells are converted or unsuccessful (dry or cool) producers, and which were drilled only for injection.

The 80% overall success rate suggests that a 60% success rate for production wells during the confirmation phase is probably reasonable, because confirmation drilling is based on very limited data about the deep resource, and the reservoir information gathered during confirmation later leads to the higher overall success rate of combined confirmation and development.

### **3. DISCLAIMER**

It is emphasized that the exploration and resource confirmation programs herein are not necessarily the ones that will be followed by geothermal developers, since every developer brings its own experience and bias to the exploration/confirmation process. Additionally, the estimated costs are only approximate, since real program costs can vary significantly from area to area and time to time, due to economic factors that may be out of the control of any given project. Drilling costs, for example, vary historically with the amount of competing activity at other projects and the availability of drilling rigs. However, the programs and estimated costs herein are believed to be reasonable.



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***Table IV-1: Unit Costs and Other Factors for Exploration and Confirmation***

| <i>Phase Method</i>                         | <i>Unit</i> | <i>Cost per unit</i> | <i>(1) Comment</i>  |
|---|-------------|----------------------|---|
| <b>Exploration</b>                          |             |                      |   |
| Drilling: ID slim hole(s)                   | foot        | \$140.00             | Based on recent experience in Nevada. The cost may be as low as \$100/ft if drilling is easy (as in poorly consolidated sediments) and a rig is available locally, to \$200/ft if drilling is difficult and mobilization costs are high. For the exploration associated with a given project area and with the goal of developing several 10s of MW, a developer would be unlikely to spend more than \$600 - \$1000K on ID Slim holes. Accordingly, the number of holes and estimated footage to be drilled is limited to not exceed this range. This cost includes mobilization. Access (roads and pads) to the drill site(s), and temperature logging are separate items.              |
| Drilling: ID Slim hole(s): roads and pads   | well        | \$50,000.00          | May be much less on flat topography   |
| Drilling: ID Slim hole(s): temperature logs | well        | \$5,000.00           | Most of the cost is mobilization, so decreases with an increasing number of holes to be logged.   |
| Drilling: TG hole(s)                        | foot        | \$15.00              | Based on past experience in Nevada. The cost may be as little as several thousand dollars per 500 ft hole (about \$5/ft) to \$25-\$50/ft, depending upon the difficulty of drilling and access. Includes mobilization, access (roads/skidding/pads) and the cost of temperature logging.  |
| Geochemistry surveys                        | project     | \$30,000.00          | Approximate lumped cost for a selected combination of spring/well water, spring/well gas, soil gas (helium or radon) and soil mercury surveys for the (new or additional) exploration of an area where the amount of existing fluids chemistry data and information is small. Any one of these surveys is likely to cost \$10,000-\$20,000 and doing more than two is likely to be difficult to justify. Many exploration sites, after initial reconnaissance (assumed already done) and especially in dry lands areas, will have only a few springs and wells of interest. Spring and well data can be very useful. Soil gas and soil mercury have historically yielded minimally useful |
| Geology: field mapping                      | project     | \$20,000.00          | Cost of field mapping in sufficient detail to assist well siting. May be much less depending upon amount of existing data and extent of rock exposures.   |

| <i>Phase Method</i>                         | <i>Unit</i> | <i>Cost per unit</i> | <i>(1) Comment</i>   |
|---|-------------|----------------------|--|
| Geophysical survey: gravity                 | project     | \$25,000.00          | Often very useful to assist well siting. Generally considered to be cost-effective.  |
| Geophysical survey: ground magnetics        | project     | \$12,500.00          | Generally considered to be cost-effective although results do not always have a clear interpretation.  |
| Geophysical survey: MT or DC resistivity    | project     | \$200,000.00         | Based on about 200 stations at a cost of \$1,000/station. Includes reporting and modeling of the results. Generally, a survey requires 50 to 200 stations to yield enough information to be useful and allow the calculation of a resistivity model. MT includes related techniques (TDEM, CSAMT, AMT).  |
| Other                                       | project     | \$10,000.00          | Default cost allows for minor data collection. Other surveys may be considered and added to this category. Includes:<br>a) seismic surveys (active reflection and refraction and passive monitoring)<br>b) hydrologic surveys<br>c) self-potential (SP) surveys, and<br>d) 1-meter soil temperature surveys.   |
| Well Test: ID slim hole, 3-10 days          | well        | \$40,000.00          | Usually an injection test. Rarely a flow test. The common cost range is \$30,000 -   |
| Administration                              | project     |                      | Standard cost: 10% of all other exploration costs  |
| Reporting-Doc: data integration/study/model | project     |                      | Standard cost: 10% of all other exploration costs except administration  |
| <b>Confirmation</b>                         |             |                      |  |
| Drilling: 'full' diameter hole(s)           | foot        |                      | Cost per foot is calculated using the formula that relates well cost to total well depth. See final report section 3.3 and Table 6. This cost includes drilling, mud logging, temperature logging, geophysical logging, mobilization and road and pad construction. Cost in \$ = 240,785 + 210*(depth in feet) + 0.019069*(depth in feet) <sup>2</sup> . Adjustments for special cases are handled using the drilling cost factor or the Other |
| Drilling: Hole Productivity                 | °F          |                      | Hole productivity (used in the estimation of total feet to be drilled) is estimated using the formula that relates well productivity to resource temperature. See final report section 3.3 and Table 6. MW/well = (average reservoir temperature in °F)/50 – 3.5. This relationship is very approximate, and adjustments are made for individual projects using the drilling cost factor.  |
| Drilling: Unsuccessful hole factor          | %           |                      | A standard unsuccessful hole factor of 40% (60% of confirmation holes successful as commercially viable production wells; 40% dry or otherwise unsuccessful). See Appendix IV.   |
| Other                                       | project     | \$20,000.00          | Default cost allows for other data collection and contingencies. A re-visit to exploration surveys may be considered and added to this category, to assist   |

| <i>Phase Method</i>                          | <i>Unit</i> | <i>Cost per unit</i> | <i>(1) Comment</i>   |
|--|-------------|----------------------|--|
| Well Test: full diameter hole, 3-10 days     | well        | \$70,000.00          | Each successful deep hole is assumed to require a test.  |
| Well Test: multi-well field test, 15-30 days | project     | \$100,000.00         | Each successful confirmation project is assumed to require a test, which may include reservoir interference measurements in both production and injection wells. The cost may vary from about \$100,000 to \$200,000, depending upon the number of |
| Administration                               | project     |                      | Standard cost: 7.5% of all other confirmation costs  |
| Regulatory compliance                        | project     |                      | Standard cost: 5.0% of drilling. Includes permitting and environmental compliance (the cost of which may be highly variable, depending upon local conditions and   |
| Reporting-Doc: data integration/study/model  | project     |                      | Standard cost: 5.0% of drilling costs. Includes data compilation, integration, interpretation and the preparation of a bankable report.  |

*(1) These costs per unit serve as an initial guide for developing exploration and confirmation program cost estimates. When the estimates are made, all exploration unit costs and most confirmation unit costs may be adjusted by applying a cost adjustment factor.*

**Table IV-2: Totals of full-diameter, production and injection wells at geothermal projects in California and Nevada<sup>1</sup>**

| PROJID | Dist/ Area/ Field                 | Area/ Power Plant                   | PRP Area | Installed MW |      |      | MW Produced (year) | Plant Technology      | Total Drd (T) | Production (P) |      | Injection (I) |      | P+I <sup>2</sup> | Active I/P | (P+I)/T | Adj. (P+I)/T <sup>3</sup> | Comment   |
|--------|-----------------------------------|-------------------------------------|----------|--------------|------|------|--------------------|-----------------------|---------------|----------------|------|---------------|------|------------------|------------|---------|---------------------------|---|
|        |                                   |                                     |          | St.          | gr   | net  |                    |                       |               | Tot.           | Act. | Tot.          | Act. |                  |            |         |                           |   |
| BEO00  | Beowawe                           |                                     | 1        | NV           | 16.7 | 16   | 15 (1998)          | Dual Flash            | 17            | 3              | 3    | 2             | 1    | 5                | 0.33       | 0.29    | 0.56                      | Total drilled (from Figure BEO00-1) includes many wells drilled very early Adjusted (P+I)/T assumes total of 9.   |
| BRA00  | Brady's Hot Springs               |                                     | 1        | NV           | 26   | 20   | 15.0 gr (2000)     | Dual Flash + Binary   | 39            | 11             | 7    | 9             | 9    | 20               | 1.29       | 0.51    | 0.77                      | Adjusted (P+I)/T assumes total of 26  |
| COS00  | Coso                              | Field-wide Summary                  | 4        | CA           | 300  | 270  | 281 (2001)         | Dual Flash            | 153           | 84             | 84   | 32            | 31   | 116              | 0.37       | 0.76    | 0.94                      | T includes c.30 abandoned producers and injectors and about 8 "non-commercial" wells. Adjusted (P+I)/T assumes total of 124   |
| DES00  | Desert Peak                       |                                     | 1        | NV           | 11   | 9.9  | 9.9 (2000)         | Dual Flash            | 7             | 3              | 2    | 1             | 1    | 4                | 0.50       | 0.57    | 0.67                      | Adjusted (P+I)/T assumes total of 6   |
| DIX00  | Dixie Valley                      | Caithness Dixie Valley              | 2        | NV           | 62   | 56   | 66+(2000)          | Single Flash          | 25            | 9              | 7    | 10            | 10   | 19               | 1.43       | 0.76    | 0.76                      |   |
| EAS00  | East Mesa                         | Field-wide summary                  | 4        | CA           | 73   | 56   | 49.7               | Binary-Air Cooled(N1) | 104           | 45             | 35   | 51            | 44   | 96               | 1.26       | 0.92    | 0.92                      |   |
| EMP00  | Empire (San Emidio)               | Field-wide summary                  | 1        | NV           | 4.8  | 4.6  |                    | Binary                | 25            | 3              | 3    | 8             | 3    | 11               | 1.00       | 0.44    | 0.69                      | Adjusted (P+I)/T assumes total of 16  |
| FIS00  | Fish Lake (Valley)                |                                     | 2        | NV           |      |      |                    |                       | 5             | 2              |      | 2             |      |                  |            |         |                           |   |
| GEY00  | Geysers                           | Field-wide Summary                  | 4        | CA           | 1000 | 900  | 850 (c.2002)       | Dry Steam             |               |                | 424  |               | 43   | 467              | 0.10       |         |                           |   |
| HEB01  | Heber                             | Heber (HGC)                         | 4        | CA           | 52   | 47   |                    | Dual Flash            | 42            | 11             | 11   | 10            | 10   | 21               | 0.91       |         |                           |   |
| HEB02  | Heber                             | Second Imperial Geoth. (SIGC)       | 4        | CA           | 48   | 32   |                    | Binary                | 26            | 11             | 11   | 15            | 11   | 26               | 1.00       | 0.69    | 0.84                      | Adjusted (P+I)/T assumes a total of 56  |
| HON01  | Honey Lake                        | Amedee                              | 1        | CA           | 3.2  | 1.5  | 0.75 net (2002-3)  | Binary-Water Cooled   | 5             | 2              | 2    |               |      | 2                | 0.00       | 0.40    | 0.67                      | (P+I)/T-adjusted assumes total of 3   |
| HON02  | Honey Lake                        | Wendel/Wineagle                     | 1        | CA           | 0.7  | 0.4  | 0.4 net            | Binary-Water Cooled   | 2             | 1              | 1    |               |      | 1                | 0.00       | 0.50    | 0.50                      |   |
| HON03  | Honey Lake                        | Wendel/Honey Lake Power             | 1        | CA           | 2.5  | 1.5  |                    | Hybrid                | 3             | 2              | 1    | 1             | 1    | 3                | 1.00       | 1.00    | 1.00                      |   |
| LAK00  | Lake City / Surprise Valley       | Lake City                           | 4        | CA           |      |      |                    |                       | 5             | 1              |      |               |      |                  |            |         |                           |   |
| LVC00  | Diablo                            | Long Valley - Casa MP Field Summary | 4        | CA           | 40   | 30.1 |                    | Binary-Air Cooled     | c.28          | 12             | 8    | 7             | 5    | 19               | 0.63       | 0.68    | 0.86                      | (P+I)/T-adjusted assumes total of 22  |
| MED02  | Medicine Lake                     | Telephone Flat                      | 4        | CA           |      |      |                    | Dual Flash            | 4             | 3              |      |               |      | 3                |            | 0.75    | 0.75                      | Unknown whether the NC/Dry hole(s) could be used for injection  |
| NIL00  | Niland                            |                                     | 4        | CA           |      |      |                    |                       | 5             | 3              |      |               |      |                  |            |         |                           |   |
| RYE01  | Rye Patch-Humboldt House District | Rye Patch                           | 1        | NV           |      |      |                    |                       | 11            | 67             |      |               |      |                  |            |         |                           | Several producers may be marginal and several NC/Dry may be suitable for injection.   |
| SAL00  | Salton Sea                        | Field-wide summary                  | 4        | CA           | 335  | 326  | 340+               | Dual Flash            | 103           |                | 31   |               | 26   | 57               | 0.84       | 0.55    | 0.90                      | T does not include many sidetracks and re-drills, does include some early exploration wells and many production wells abandoned and replaced with newer titanium casing. Adjusted (P+I)/T assumes total of 63 |
| SBK00  | Sulphur Bank                      | Clear Lake                          | 4        | CA           |      |      |                    |                       | 5             | 1              |      |               |      |                  |            |         |                           |   |
| SOD00  | Soda Lake                         | Soda Lake No.1/No.2                 | 1        | NV           | 26.1 | 16.6 | 10 net (2000)      | Binary-Air Cooled     | c.25          | 5              | 5    | 5             | 5    | 10               | 1.00       | 0.40    | 0.67                      | (P+I)/T-adjusted assumes total of 15  |
| STE01  | Steamboat Hot Sprs                | Lower SB: Steamboat I-1A            | 1        | NV           | 9.2  | 7.1  | 2.23 (2001)        | Binary-Air Cooled     | 18            | 12             | 11   | 6             | 6    | 18               | 0.55       | 1.00    | 1.00                      |   |
| STE05  | Steamboat Hot Sprs                | Upper SB: Yankee-Caithness          | 1        | NV           | 14.4 | 13   | 14.44 (2000)       | Dual Flash            | c.8           | 6              | 3    | 1             | 1    | 7                | 0.33       | 0.88    | 0.88                      |   |
| STI00  | Stillwater                        | Stillwater Geothermal 1             | 1        | NV           | 19   | 10   | 7.5 net (2000)     | Binary-Air Cooled     | c.16          | 7              | 4    | 5             | 3    | 12               | 0.75       | 0.75    | 0.86                      | (P+I)/T-adjusted assumes total of 14  |
| STI01  | Stillwater                        | Stillwater N Expansion              | 1        | NV           |      |      |                    |                       | 3             | 3              |      |               |      |                  |            |         |                           |   |
| WAB00  | Wabuska                           |                                     | 1        | NV           | 1.45 | 1.2  | 1.2 (2000)         | Binary                | c.5           | 1              | 1    |               |      | 1                | 0.00       | 0.2     | 0.5                       | (P+I)/T-adjusted assumes total of 2   |

**Averages**    **0.66**    **0.63**    **0.77**    Average of all data entries BEO00 through WAB00.  
**Average all projects with injection (except Geysers)**    **0.82**    **0.68**    **0.82**  
**Average flash plants**    **0.75**    **0.63**    **0.79**  
**Average binary plants (excluding plants without injection)**    **0.93**    **0.67**    **0.82**

**Notes:**

- 1) Data in this table have been compiled from the Hetch Hetchy / SFPUC Programatic Renewable Energy Project geothermal database, of which this table is a part. Source documents for the data in this table are contained therein.
- 2) Sum of total P and I wells, if available, otherwise, sum of active P and I wells.
- 3) Total wells drilled often includes holes drilled in the 1960s - 1970s which were questionably sited and/or designed, or drilled before field development was economically or technically possible. Adjusted (P+I)/T reflects an adjustment of T to a value that is believed likely at the same project if it were started in year 2003, in the context of contemporary exploration/confirmation and development technology and economics.

**Appendix V**  
**Exploration, Confirmation and Development Costs –**  
**Detail by Project**  
**(example)**



Hetch Hetchy/SFPUC Programmatic Renewable Energy Project  
 Project: 1.3 New Geothermal Site Identification and Qualification  
 Project Team: GeothermEx, Inc.  
 Task: 1.3.10 Final Project Report  
 Subject: D.1.3.10.3 Final Report

**Appendix V:  
 Exploration, Confirmation and  
 Development Costs - Detail by  
 Project (example)**

***Exploration, Confirmation and Development Costs - Detail by Project***

|                   |  |                                   |   |
|-------------------|--|-----------------------------------|---|
| MW installed:     | <input type="text" value="0"/> -gr <input type="text"/> -net | <b>PROJID</b>                     | <input type="text" value="AUR00"/>  |
| MW produced (yr): | <input type="text"/>   | <b>Name - District/Area/Field</b> | <input type="text" value="Aurora"/>   |
| Start Date (Yr):  | <input type="text"/>   | <b>Name - Area / Power Plant</b>  | <input type="text"/>  |
|                   |  | <b>State</b>                      | <input type="text" value="NV"/> <b>PRP Area:</b> <input type="text" value="2"/> |
|                   |  | <b>County</b>                     | <input type="text" value="Mineral"/>  |

**Exploration Program (1)**

| <i>Method</i>                    | <i>Unit</i> | <i># of<br/>Units</i> | <i>Std.<br/>Cost/unit</i> | <i>Cost<br/>Adjustment<br/>Factor</i> | <i>Cost</i> | <i>Comment</i>  |
|----------------------------------|-------------|-----------------------|---------------------------|---------------------------------------|-------------|---|
| Drilling: ID slim hole(s)        | foot        | 4000                  | \$140                     | 1.0                                   | \$560,000   | Two holes to 2000 ft each   |
| Drilling: TG hole(s)             | foot        | 2500                  | \$15                      | 1.0                                   | \$37,500    | Five holes to 500 ft each, to better define the heat anomaly between the Aurora hole and the hot area at Borealis mine. |
| Drilling: ID Slim hole(s): roads | well        | 2                     | \$50,000                  | 0.5                                   | \$50,000    |   |
| Drilling: ID Slim hole(s): tempe | well        | 2                     | \$5,000                   | 1.0                                   | \$10,000    |   |
| Geology: field mapping           | project     | 1                     | \$20,000                  | 1.0                                   | \$20,000    | May be less if Phillips data can be obtained.   |
| Geophysical survey: gravity      | project     | 1                     | \$25,000                  | 1.0                                   | \$25,000    | May be less if Phillips did survey and data can be obtained.  |
| Geophysical survey: ground m     | project     | 1                     | \$12,500                  | 1.0                                   | \$12,500    | May be less if Phillips did survey and data can be obtained.  |

|                                 |                  |
|---------------------------------|------------------|
| <i>Subtotal:</i>                | <u>\$715,000</u> |
| <i>Reporting-Documentation:</i> | \$71,500         |
| <i>Administration:</i>          | <u>\$71,500</u>  |
| <i>Exploration Total:</i>       | <b>\$858,000</b> |

### Confirmation Program for Minimum (90% Probable) Estimated Capacity (2)

|                             |             |  |     |                        |                     |                |
|-----------------------------|-------------|--|-----|------------------------|---------------------|----------------|
| <i>Estimated Capacity</i>   | 31 MW       | <i>Cost Factor: Drilling</i>               | 1.0 | <i>Total Drilling:</i> | \$8,748,000         | <i>Comment</i> |
| <i>Wellhead MW in use</i>   | .MW         | <i>Cost Factor: Well Test(s)</i>           | 1.0 | <i>Well Tests:</i>     | \$140,000           |                |
| <i>Wellhead MW unused</i>   | .MW         | <i>Cost Factor: Field Test</i>             | 1.0 | <i>Field Test:</i>     | \$100,000           |                |
| <i>Additional MW needed</i> | 31. MW      |  |     | <i>Other Cost(s):</i>  | \$0                 |                |
| <i>Need To Confirm</i>      | 7.8 MW      |  |     | <i>Regulatory:</i>     | \$437,000           |                |
| <i>Expect/well</i>          | 3.4 MW      |  |     | <i>Reporting:</i>      | \$437,000           |                |
| <i>Expect to drill</i>      | 4 wells     |  |     | <i>Administration:</i> | \$740,000           |                |
| <i>Expected TD/well</i>     | 6000 ft     |  |     |                        |                     |                |
| <i>Expected Cost/well</i>   | \$2,187,000 | <i>Estimated Total Confirmation Cost :</i> |     |                        | <b>\$10,602,000</b> |                |

PROJID: AUR00

### Confirmation Program for Most-likely (Modal) Estimated Capacity (2)

|                             |             |  |     |                        |                     |                |
|-----------------------------|-------------|--|-----|------------------------|---------------------|----------------|
| <i>Estimated Capacity</i>   | 51 MW       | <i>Cost Factor: Drilling</i>               | 1.0 | <i>Total Drilling:</i> | \$13,122,000        | <i>Comment</i> |
| <i>Wellhead MW in use</i>   | . MW        | <i>Cost Factor: Well Test(s)</i>           | 1.0 | <i>Well Tests:</i>     | \$280,000           |                |
| <i>Wellhead MW unused</i>   | . MW        | <i>Cost Factor: Field Test</i>             | 1.0 | <i>Field Test:</i>     | \$100,000           |                |
| <i>Additional MW needed</i> | 51. MW      |  |     | <i>Other Cost(s):</i>  | \$0                 |                |
| <i>Need To Confirm</i>      | 12.8 MW     |  |     | <i>Regulatory:</i>     | \$656,000           |                |
| <i>Expect/well</i>          | 3.4 MW      |  |     | <i>Reporting:</i>      | \$656,000           |                |
| <i>Expect to drill</i>      | 6 wells     |  |     | <i>Administration:</i> | \$1,111,000         |                |
| <i>Expected TD/well</i>     | 6000 ft     |  |     |                        |                     |                |
| <i>Expected Cost/well</i>   | \$2,187,000 | <i>Estimated Total Confirmation Cost :</i> |     |                        | <b>\$15,925,000</b> |                |

PROJID: AUR00

### Development Program for Minimum (90% Probable) Estimated Capacity <sup>(3)</sup>

|                                  |                                     |   |                |  |
|----------------------------------|-------------------------------------|---|----------------|--|
| <i>Estimated Capacity</i>        | 31 MW                               | <b>Plant + Gathering System (On-Site Capital)</b> | <i>Comment</i> | <i>PROJID: AUR00</i>   |
| <b>Drilling (well) Cost:</b>     |                                     | <i>Existing plant</i>                             | .0 MW          |  |
| <i>In use at wellhead</i>        | . MW                                | <i>New Plant</i>                                  | 31.0 MW        |  |
| <i>Unused at wellhead</i>        | . MW                                | <i>On-site Unit Cost</i>                          | \$ 1,500 /kW   |  |
| <i>Confirmation plan</i>         | 7.8 MW <i>at wellhead</i>           | <i>Total On-site Capital</i>                      | \$46,500,000   |  |
| <i>Development drilling plan</i> | 24.8 MW <i>for 105% at wellhead</i> |   |                |  |
| <i>Expect/well</i>               | 3.4 MW                              | <b>Other:</b>                                     |                |  |
| <i>Production need (P)</i>       | 7 wells                             | <i>Other Development Cost</i>                     | \$0            |  |
| <i>Injectors/Producers</i>       | 0.95                                | <b>Subtotal all On-Site Costs:</b>                |                |  |
| <i>Injection need (I)</i>        | 7 wells                             | <i>Total Site Development</i>                     | \$85,866,000   |  |
| <i>P+I success rate</i>          | 0.80                                |   |                |  |
| <i>Expect to drill total</i>     | 18 wells                            | <b>Transmission Line:</b>                         |                |  |
| <i>Expected TD/well</i>          | 6000 ft                             | <i>Line Cost (unit or tot.):</i>                  | \$268,000      | <i>Transmission Line Comment:</i>                                      |
| <i>Expected Cost/well</i>        | \$2,187,000                         | <i>Cost Factor (1 or tot.):</i>                   | 2.0            | Cost Factor = about 2 miles to an existing 55-69 kV transmission line. |
| <i>Cost Factor</i> 1.0           |                                     | <i>Total Trans Ln:</i>                            | \$536,000      |  |
| <i>Dev. Drilling</i>             |                                     | <b>Total Development Cost:</b>                    |                |  |
| <i>Total Dev. Drilling</i>       | \$39,366,000                        |   | \$86,402,000   |  |

### Development Program for Most-likely (Modal) Estimated Capacity (3)

|                                  |                                     |   |                |  |
|----------------------------------|-------------------------------------|---|----------------|--|
| <i>Estimated Capacity</i>        | 51 MW                               | <b>Plant + Gathering System (On-Site Capital)</b> | <i>Comment</i> | <i>PROJID: AUR00</i>   |
| <b>Drilling (well) Cost:</b>     |                                     | <i>Existing plant</i>                             | .0 MW          |  |
| <i>In use at wellhead</i>        | . MW                                | <i>New Plant</i>                                  | 51.0 MW        |  |
| <i>Unused at wellhead</i>        | . MW                                | <i>On-site Unit Cost</i>                          | \$ 1,500 /kW   |  |
| <i>Confirmation plan</i>         | 12.8 MW <i>at wellhead</i>          | <i>Total On-site Capital</i>                      | \$76,500,000   |  |
| <i>Development drilling plan</i> | 40.8 MW <i>for 105% at wellhead</i> |   |                |  |
| <i>Expect/well</i>               | 3.4 MW                              | <b>Other:</b>                                     |                |  |
| <i>Production need (P)</i>       | 12 wells                            | <i>Other Development Cost</i>                     | \$0            |  |
| <i>Injectors/Producers</i>       | 0.95                                | <b>Subtotal all On-Site Costs:</b>                |                |  |
| <i>Injection need (I)</i>        | 11 wells                            | <i>Total Site Development</i>                     | \$139,923,000  |  |
| <i>P+I success rate</i>          | 0.80                                |   |                |  |
| <i>Expect to drill total</i>     | 29 wells                            | <b>Transmission Line:</b>                         |                |  |
| <i>Expected TD/well</i>          | 6000 ft                             | <i>Line Cost (unit or tot.):</i>                  | \$268,000      | <i>Transmission Line Comment:</i>                                      |
| <i>Expected Cost/well</i>        | \$2,187,000                         | <i>Cost Factor (1 or tot.):</i>                   | 2.0            | Cost Factor = about 2 miles to an existing 55-69 kV transmission line. |
| <i>Cost Factor 1.0</i>           |                                     | <i>Total Trans Ln:</i>                            | \$536,000      |  |
| <i>Dev. Drilling</i>             |                                     | <b>Total Development Cost:</b>                    |                |  |
| <i>Total Dev. Drilling</i>       | \$63,423,000                        |   | \$140,459,000  |  |

## Summary of Total Exploration + Confirmation + Development Cost

PROJID: AUR00

|  | <u>GENERATION ESTIMATE</u>    |                            |
|--|-------------------------------|----------------------------|
|  | <u>Minimum (90% Probable)</u> | <u>Most-likely (Modal)</u> |
| <i>Resource Capacity Estimate:</i>   | 31.0 MW                       | 51.0 MW                    |
| <i>Estimate exceeds current used + excess proven wellhead capacity by:</i>           | 31.0 MW                       | 51.0 MW                    |
| <i>Estimate exceeds current power plant generation capacity by:</i>                  | 31.0 MW                       | 51.0 MW                    |
| <i>Net new development:</i>  | 31.0 MW                       | 51.0 MW                    |
| <u>COST ESTIMATES TO EXPLORE, CONFIRM AND DEVELOP TO ESTIMATED RESOURCE CAPACITY</u> |                               |                            |
| <i>Total Exploration:</i>  | \$858,000                     | \$858,000                  |
| <i>Total Confirmation:</i>   | \$10,602,000                  | \$15,925,000               |
| <i>Total Exploration + Confirmation:</i>   | \$11,460,000                  | \$16,783,000               |
| <i>Total Site Development:</i>   | \$85,866,000                  | \$139,923,000              |
| <i>Total Exploration + Confirmation + Site Development:</i>                          | \$97,326,000                  | \$156,706,000              |
| <i>Transmission Line:</i>  | \$536,000                     | \$536,000                  |
| <i>Total Exploration + Confirmation + Site Development + Transmission:</i>           | \$97,862,000                  | \$157,242,000              |

NOTES:

(1),(2) See definitions of terms and headings in Appendices III, IV and VI.

(2) Estimated Capacity is the total estimated generation capacity of the resource (Monte Carlo heat-in-place estimate Minimum or Most-likely value).

Wellhead MW in use and unused are based on current production and/or the results of drilling and testing wells that are not in use.

Additional MW needed is the difference between Estimated Capacity and the sum of Wellhead MW in use and unused.

Need to Confirm is 25% of the expansion from current production to Estimated Capacity, minus wellhead MW proven but unused. It is likely that a lending institution will demand that this percentage be proven at the wellhead, before committing to loan funds for field development and power plant construction.

Expect/well is the expected average MW per successful production well, calculated as a function of resource temperature (see main report section 3.3 and Table IV-1 of Appendix IV).

Expect to drill is the number of wells planned to prove the Need to Confirm value, calculated from Expect/well and Need to Confirm, and assuming a success rate of 0.6.

Expected TD/well is the expected average well depth, calculated from most-likely average depth to top of reservoir, and most-likely average reservoir thickness (see database entries under Reservoir Physical Properties). If most-likely values have not been estimated, then the average of estimated minimum and maximum is used.

Expected Cost/well is the expected cost for the expected TD, calculated as a function of depth (see main report section 3.3 and Table IV-1 of Appendix IV).

Drilling, Well Test and Field Test Cost Factors are adjustments that may be applied to local conditions, as explained under Comments.

Total Drilling Cost is the product of (Expect to Drill) \* (Expected Cost/well) \* (Drilling Cost Factor).

Well Tests Cost is the product (number of successful confirmation wells needed) \* (standard cost of testing, as reported in Units Costs for Exploration and Confirmation) \* (Well Test Cost Factor).

Field Test Cost is the cost of a medium to long-term multi-well field test, including pressure interference measurements, that is likely to be required by a lending institution.

Other Costs(s) may be included, and explained under Comments.

Regulatory, Reporting and Administration are standard percentages of other costs, as explained in Table IV-1 of Appendix IV.

(3) See definitions of terms and headings under note (2) above, and in Appendix VI.



**Appendix VI**  
**Methodology of Estimating Development Cost**



**Hetch Hetchy/SFPUC Programmatic Renewable Energy Project**  
**Project: 1.3 New Geothermal Site Identification and Qualification**  
**Project Team: GeothermEx, Inc.**  
**Task: 1.3.10 Final Project Report**  
**Subject: Deliverable 1.3.10.3 Final Report**

## **APPENDIX VI**

### **METHODOLOGY OF ESTIMATING DEVELOPMENT COST**

#### **1. BACKGROUND**

For every project with an estimation of generation capacity, development cost is estimated as the sum of three components:

1. Drilling Cost
2. All other On-site Capital Costs, and
3. Transmission Line Cost.

#### **2. DRILLING COST**

The cost of development drilling (which includes well completion) is calculated using an approach similar to the cost of confirmation drilling (see Appendix IV), adjusted to account for the wellhead MW already confirmed, and for drilling injection wells. Injection wells are not included in the confirmation estimate, as it is assumed that well tests can be conducted by injecting into other successful production wells, unsuccessful production wells and/or existing slim holes.

##### **2.1. General Process**

The process of development drilling cost estimation is as follows:

- Expected MW/well is estimated from reservoir temperature. (The relationship between temperature and productivity is described in the main report section 3.3.2, and also listed in Table IV-1 of Appendix IV.)
- Number of production wells needed (P) is estimated from MW/well and the total wellhead MW needed for development (including a 5% reserve), after subtracting the 25% of required wellhead capacity already demonstrated at the stage of project confirmation.
- All projects with an average reservoir temperature of 380°F or less are assumed to be binary, and projects with average reservoir temperature above 380°F are assumed to be flashed steam (except for The Geysers, which is assumed to be dry steam).
- Number of injection wells needed (I) is initially assumed to be 75% of production wells in the case of a flashed steam project, 95% of production wells in the case of a binary project, and 10% of production wells for The Geysers (dry steam). (This is based on data in Table IV-2 of Appendix IV, see section 2.2 below.) The ratio (I/P) can be changed for an individual project,

## **Hetch Hetchy/SFPUC Programmatic Renewable Energy Project**

**Project:** 1.3 New Geothermal Site Identification and Qualification

**Project Team:** GeothermEx, Inc.

**Task:** 1.3.10 Final Project Report

**Subject:** Deliverable 1.3.10.3 Final Report

based on specific considerations, as described in the comments on development cost estimates (Table 10).

The I/P ratio is applied only to development drilling; *i.e.*, it is assumed that the confirmation program will have yielded enough injectivity that injection from successful confirmation holes later used as producers can be handled by other confirmation holes or other existing holes. This may cause the total number of needed injectors to be underestimated by up to 25% and the total number of development wells to be underestimated by up to about 12%. It is assumed that this is offset by the assumption of identical cost for production and injection wells (see section 2.3 below).

- The estimated total number of producers (P) and injectors (I) is corrected by a success rate  $(P+I)/T$ , where T is total wells drilled (see section 2.2 below). The default value of this ratio is set at 0.8 (also based on data in Table IV-2).
- Numbers of production, injection and total wells are calculated in sequence, and all interim and final residuals are rounded as follows:
  - i. all residuals  $<0.5$  are rounded down to the nearest lower integer value
  - ii. all residuals  $\geq 0.5$  are rounded up to the nearest higher integer value
  - iii. any value  $>0$  and  $<1$  gets rounded to 1.

For example: 3.3 producers is rounded to 3. At  $I/P = 0.95$  this means 2.85 injectors, which is rounded to 3. At total success rate 0.8 this means 7.5 wells, which is rounded to 8.

- Production and injection wells are assumed to have identical depths and costs per well (see section 2.3 below). Average well depth is calculated from reservoir characteristics, and cost/well is calculated from depth. (Drilling cost/foot is described in the main report, section 3.3.1, and listed in Table IV-1 of Appendix IV.)
- A development drilling cost factor is applied, to correct for assumptions made that are likely to be inaccurate. For example, if MW/well based on temperature is 6 MW, but historic drilling results in the area indicate 3 MW, then the Cost factor is 2.0 (twice as many wells needed).
- Total development drilling cost is estimated as (total number of wells) \* (cost factor) \* (cost/well). The wells at some hypersaline fields in the Imperial Valley of California are assumed to need corrosion-resistant titanium casing, which is included later as a separate component of total development cost.

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## 2.2. Production/Injection Well Ratio and Drilling Success Rate

Table IV-2 of Appendix IV is a compilation of historic well information from projects in the database, which shows that the ratio of active injection wells to active production wells ranges from as little as 0 at a few small projects where there is no injection, to 0.1 at The Geysers steam field, to as high as 1.3 at Bradys Hot Springs (Flash and Binary) and East Mesa (Binary) and 1.4 at Dixie Valley (Flash). The average of all projects with injection (excluding The Geysers) is 0.82, the average at flash steam projects is 0.75 and the average at binary plants (excluding plants without injection) is 0.93. Although the flash and binary averages are used in the development cost calculation, it is recognized that these averages have a very high standard deviation, and an adjustment is made for each individual project if information allows.

Table IV-2 also shows that if the sum of total available (active and idle) production (P) and injection (I) wells at a project is divided by the number of full-sized wells drilled (T), the result  $(P+I)/T$  has ranged from about 0.3 to 1.0, and the average  $(P+I)/T$  is about 0.65. When experience is considered and the total T is adjusted to a best estimate for each project if developed in year 2003, the adjusted  $(P+I)/T$  becomes 0.5 to 1.0, with an average of about 0.8. This suggests that about 80% of all holes drilled at a project in year 2003 will be successful as production or injection wells, and 20% will not be successful. A separate value for production wells only has not been estimated in Table IV-2, because there is no way (without much more detailed information) to know which injection wells are converted or unsuccessful producers, and which were drilled only for injection.

The information in Table IV-2 suggests using 0.8 (80%) as the ratio of successful production and injection wells drilled to total wells drilled during field development. Strictly speaking, if the overall success rate is 80% and the success rate for confirmation of 25% of needed wellhead capacity is 60% (used for confirmation cost estimates, as explained in Appendix IV), then it follows that development drilling to 100% wellhead capacity should have a success rate of 86.67%, and development drilling to 105% wellhead capacity should have a success rate of 81.25%. We believe that 80% is a more reasonable default value for future projects where exploration has not even been completed, and an adjustment is made for each individual project if information allows.

## 2.3. Production and Injection Well Design and Drilling Cost

Injection wells are sometimes cheaper to drill than production wells, especially if shallower and/or designed with a less-expensive diameter and/or casing program. However, some wells used for injection are originally designed and drilled for production, some injection wells are deeper than corresponding production wells, and sometimes the success rate of injection well drilling is no better than the success rate of

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production well drilling. Considering these uncertainties, it is assumed herein that the production wells and the injection wells are identical in terms of cost per well.

### **3. ON-SITE CAPITAL COSTS**

On-site capital costs in addition to drilling and well completion include the costs of pumps for binary systems, water and/or steam gathering and disposal systems (including injection pumps but not injection wells), steam/water separation systems (flash plants only), the power plant, the local substation and transmission line connections (see section 4, below), pollution abatements systems (as needed), other infrastructure, surface facilities and civil works, land, regulatory and environmental compliance, other legal costs, engineering, all construction and assembly, permits, interest, administration, and initial system testing and start-up.

It is typical to consider the aggregate cost of all of these components, described simply as the cost of the power plant and gathering system, and the value used herein is US\$1,500/kW installed. This is multiplied times the difference between Estimated Generation Capacity in MW (resource capacity) and gross MW of existing installed plant capacity (if any).

The \$1,500/kW value is only approximate and has an uncertainty of about +/-25% or even more. It is based on data and information in a number of recent publications, which include Brugman and others (1996)<sup>1</sup>, Entingh and McVeigh (2003), Entingh (1997), Fredriksens and others (2000), Gawlik and Kutscher (2000), Girelli and others (1995), Greider (1998), Hiriart and Andaluz (2000), Jenkins and others (1996), Liguori (1995), Miller (1996), Owens (2002), Stefánsson (2002), Tiangco and others (1996) and Wheble and Islam (1995).

The development costs listed in these publications are not always compatible, because some describe or estimate only the cost of the power plant, others consider only a total capital cost that includes drilling and exploration, some appear to consider “plant” to include the gathering system, but are not specific about this, and only a few consider specifically the combination of plant + gathering system. In addition, very few clearly indicate that the local electrical substation (typical cost about \$60/kW) is included.

Entingh and McVeigh (2003) consider that the power plant (60%) and field piping (5%) are typically about 65% of total capital cost, and exploration, confirmation and development wells are about 35%. We consider this to be a reasonable breakdown, and using these percentages applied to cases of total development cost that includes drilling,

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<sup>1</sup> The references cited herein are listed in the main report chapter 6, section 6.1. In the Access database they appear under All Other References (General Citations) and as the report entitled Section 6.1 General References.

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some of the estimates of power plant and gathering system are as follows, sorted by increasing cost/kW (the various references cite dollar bases that range from about 1994 to 2003, but corrections for inflation are not included):

| <b><u>Plant Type</u></b> | <b><u>Plant and Gathering System</u></b><br>(US\$/kW) | <b><u>Reference</u></b>    | <b><u>Comment</u></b>  |
|--------------------------|---|----------------------------|--|
| Single flash             | \$872   | Stefánsson (2002)          | Plant, gathering system and exploration. Svartsengi, Iceland co-generation plant, (heat and electricity, 30 MW, constructed 1999) <sup>1</sup> . |
| Single flash             | \$970   | Stefánsson (2002)          | Plant, gathering system and exploration. Bjarnarflag, Iceland (detailed planning report, 40 MW, 1994) <sup>1</sup> .                             |
| Single flash             | \$1,039   | Stefánsson (2002)          | Plant, gathering system and exploration. Nesjavellir, Iceland co-generation plant (heat and electricity, 60 MW, constructed 1998) <sup>1</sup> . |
| Single flash             | \$1,040   | Entingh and McVeigh (2003) | Calculated from total development  |
| Single flash             | \$1,047   | Stefánsson (2002)          | Plant, gathering system and exploration. Krafla, Iceland (detailed planning report, 40 MW, 1999) <sup>1</sup> .                                  |
| Single flash             | \$1,150   | Stefánsson (2002)          | Plant, gathering system and exploration. Bjarnarflag, Iceland (detailed planning report, 20 MW, 1994) <sup>1</sup> .                             |
| Dual flash               | \$1,166   | Tiangco and others (1996)  | Calculated from plant average  |
| Dual flash               | \$1,170   | Entingh and McVeigh (2003) | Calculated from total development  |
| Binary                   | \$1,372   | Owens (2002)               | Calculated from total development  |

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| <b><u>Plant Type</u></b>   | <b><u>Plant and Gathering System</u></b><br>(US\$/kW) | <b><u>Reference</u></b>    | <b><u>Comment</u></b>  |
|--|---|----------------------------|--|
| Dual flash   | \$1,546   | Tiangco and others (1996)  | Calculated from total average  |
| Binary   | \$1,560   | Entingh and McVeigh (2003) | Calculated from total development  |
| Flash  | \$1,564   | Owens (2002)               | Calculated from total development (flash type not specified)   |
| Binary   | \$1,836   | Tiangco and others (1996)  | Calculated from plant average  |
| Single flash   | \$1,837   | Wheble and Islam (1995)    | Calculated from plant, Leyte Philippines (180 MW)  |
| Single flash   | \$1,938   | Wheble and Islam (1995)    | Calculated from plant, Tongonan Philippines (120 MW)   |
| Binary   | \$1,940   | Tiangco and others (1996)  | Calculated from total average  |
| Unspecified - maximum  | \$2,012   | Miller (1996)              | Calculated from plant  |
| Flash  | \$2,270   | Jenkins and others (1996)  | Calculated from plant (flash type not specified)   |
| Unspecified-minimum  | \$2,513   | Miller (1996)              | Calculated from plant  |
| Binary   | \$3,372   | Gawlik and Kutscher (2000) | Calculated from plant average. Estimates for 17 small ( $\leq 1$ MW) and very low temperature projects in the Western USA (185°F – 300°F, one 346°F) |
| Binary   | \$3,475   | Jenkins and others (1996)  | Calculated from plant  |
| 1. The estimates of Stefánsson (2002) include exploration, but no correction for the exploration component is attempted herein, because exploration is described as a “very small fraction” of the total investment costs of power plants larger than 5 – 10 MW. |   |                            |  |

The large range of these estimates is obvious and due, in no small part, to severe limitations on the amount and detail of geothermal cost data that gets released to the

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public domain from private developers in the USA (Entingh, personal communication, 25 September 2003).

The average of all \$/kW values in the table above, excluding the two highest, is \$1,500/kw, with a standard deviation of \$470/kw.

Entingh and McVeigh (2003) note that their estimates are lower than previous estimates, but cite evidence of large cost reductions in the past twenty years for both flash and binary technologies. The flash plants installed in the U.S. are typically dual flash, so the average \$1,500 /kW used herein can be compared with the Entingh and McVeigh (2003) dual flash value of \$1,170/ kW.

### **4. TRANSMISSION LINE COST**

Transmission line costs are estimated on top of on-site capital development costs, as described in the following sections. In the case of an existing project where generation capacity is expanded, it is assumed that existing transmission lines can handle this expansion. The Salton Sea field of the Imperial Valley is an exception, for which major expansion and new transmission capability are estimated.

Each transmission line estimate is based on a single chosen alternative for connection to existing or new grid capacity. It is recognized that alternative connections may be available now or in the future, but an attempt to evaluate all of the available alternatives would be outside the scope of this investigation.

#### **4.1. Area 1 (Greater Reno area of Nevada and California)<sup>2</sup>**

Transmission line costs are based on estimates provided by Woodford (2003) (Electranix Corporation), listed as Woo03a in section 6.1 of the main report. Woodward (2003) assumes that sets of new geothermal, wind power and pumped storage projects are developed in several stages, and makes cost estimates for an integrated power delivery system (referred to herein as the Woodford grid) constructed to serve these sets of new projects. These estimates include 16 geothermal projects in Northern Nevada (Table VI-1; total 662 MW)<sup>3</sup>, plus two large wind farms (500 MW each) and one pumped storage facility (600 MW). The total estimates provided by Woodford (2003) represent the cost of connecting the new generation to the 1000-kV Pacific Direct-Current Intertie

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<sup>2</sup> The geographic Areas are described in the body of the final report, section 2.4.

<sup>3</sup> The geothermal MW values used by Woodford (2003) and listed in Table VI-1 are estimates that were contained in draft deliverables under Project 1.3 that have since been updated for this final report. The new total for the same 16 projects is 495 MW (most-likely estimate). It is assumed this change would not affect the transmission line cost estimates.

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(PDCI, referred to elsewhere in the present report as the HVDC intertie). Schematic diagrams and a map of the Woodford grid are included in Woodford (2003).

Table VI-1 is a summary of the collection and delivery systems for the 16 geothermal projects alone, which has been developed by GeothermEx using the data in Woodford (2003). This includes common lines within the geothermal collection system (lines shared by more than one project), but not the collector lines from the wind farms and the pumped storage.

The local site substations at the 16 geothermal projects (Table VI-1) have per-kW costs that range from \$21 to \$186, with an average cost of \$57/kW (standard deviation \$44/kW). As explained in section 3 (above), this cost is assumed to be part of the on-site per-kW capital development cost, not part of the transmission cost.

The total transmission line cost for the integrated system that delivers power from 16 projects is \$125 million for 468 miles, with an overall average of \$268,000/mile (standard deviation \$145,000/mile). For individual transmission lines there is a wide range of line cost per mile, from \$133,000/mile to \$670,000/mile, because both 115/120-kV and 345-kV lines are involved, and each separate estimate is affected by multipliers for terrain, length, and permitting and environmental factors. The 115/120-kV lines alone (251 miles) average \$164,000/mile, and the 345-kV lines alone (217 miles) average \$388,000/mile.

The integrated collection system also includes upgrades to some substations and taps into the 345-kV common line for wind, pumped storage, and geothermal projects. Those upgrades and taps total \$49 million. If this is combined with the total line cost, then the cost per mile increases from \$268,000/mile to \$372,000/mile. However, if the line cost is adjusted to a value that would represent 115/120 kV only and combined with the \$49 million, then the cost per mile remains at approximately \$268,000.

In summary, the total transmission line cost for each of the 16 individual projects is a combination of two components: a) the transmission line from the site substation to the first node in the delivery network where power from that project is combined with power from at least one other project; and b) the project's MW-weighted share of all common lines from that node forward, including new and/or upgraded substations and taps within the common system. These costs have been calculated, using the data in Table VI-1, and the results for the 16 projects are included in the total development costs in the MS Access database for Project 1.3. The range of transmission line costs per project in Area 1 is as low as \$3.7 million and as high as \$31.6 million, and the range per kW is as low as \$99/kW and as high as \$627/kW.

Area 1 projects that are not in the set of 16 considered by Woodford (2003) are handled by assuming that they can be connected to the Woodford grid, or otherwise to an existing transmission line, if closer. (It is assumed that the Woodford grid or the existing line can

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handle the extra capacity, which is not necessarily true.) The reference for existing lines is Nevada Bureau of Mines and Geology Map 126 (Shevenell and others, 2000; She00a), which shows transmission lines greater than or equal to ( $\geq$ ) 55 kV in Nevada, supplemented by project and transmission line locations on U.S.G.S. topographic maps. The cost of connection is calculated on the basis of estimated distance from the project location to the nearest point along the line, at \$268,000/mile. Any exceptions are explained in comments to the transmission line cost estimates in the MS Access database.

### 4.2. Area 2 (Nevada with direct access to California)

These projects are assumed to be connected to the line into California from Dixie Valley (230-kV Dixie Valley – Sierra Pacific line), or to another existing line (Shevenell and others, 2000, and U.S.G.S. topographic maps), if closer. (It is assumed that the existing line can handle extra capacity, which is not necessarily true.) The approximate cost is calculated on the basis of estimated distance from the project location to the nearest point along the line, at \$268,000/mile. Note that connection of a single project directly to the PDCI is regarded as not possible, even if the project is closer to the PDCI.

### 4.3. Area 3 (Other Nevada)

These projects are assumed to be connected directly to the Woodford grid, or to another existing line (Shevenell and others, 2000, and U.S.G.S. topographic maps), if closer. (It is assumed that the existing line can handle extra capacity, which is not necessarily true.) The approximate cost is calculated on the basis of estimated distance from the project location to the nearest point along the line, at \$268,000/mile. Note that connection of a single project directly to the PDCI is regarded as not possible, even if the project is closer to the PDCI.

### 4.4. Area 4 (All Other California)

The cost of connecting 2,000 MW of new power generation in the Salton Sea area (Imperial Valley) to the PDCI has been estimated by Woodford (2003), in which the total for a 500-kV transmission line plus substations is \$237.1 million. Transmission estimates for resources in the broader Salton Sea area are assigned as follows.

#### **1. Projects BRW01, BRW02, BRW03, NIL00, SAL00 (all $\geq$ 62 MW):**

The current estimate for most likely new or expanded capacity at these fields is 1802 MW, which is close to the 2000 MW used by Woodford (2003). The \$237.1 million cost is apportioned among these 5 projects on a MW fraction basis. In addition, it is assumed that \$237.1 million represents transmission starting at the Salton Sea field (project SAL00), so transmission to that location from the other projects is also estimated, at

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\$200,000/mile, which is assumed to cover a 115/120-kV line plus substations and taps to the 500-kV line.

2. New small projects at the margins of the Imperial Valley (DUN00, GLA00, SUP00):

It is assumed that transmission can tap into an existing transmission line at the nearest existing geothermal power plant, and the line cost to that location is estimated at \$180,000/mile, which is assumed to cover a 115/120-kV line only.

3. Expansions at existing projects (except SAL00):

As for existing power generating projects in the other geographic Areas, it is assumed that there is no new transmission line cost.

Transmission line costs for Area 4 projects not in the Imperial Valley (e.g. Medicine Lake) are handled as individual cases and presented (with annotations) in the PIER Geothermal Database.

### **5. DISCLAIMER**

It is emphasized that the development programs used herein for cost estimation are only approximate and may not be followed, since every developer brings its own experience, bias and opportunities to the development process. Additionally, real program costs can vary significantly from area to area and time to time, due to economic factors that may be out of the control of any given project. Drilling costs, for example, vary historically with the amount of competing activity at other projects and the availability of drilling rigs. Transmission line costs depend both on project location and on the location and availability of existing transmission capacity (which is a major uncertainty). In spite of these uncertainties, the estimated overall costs herein are believed to be reasonable.

| Table VI-1: Summary of estimated costs of site substations, transmission lines and collector/line substations and taps |                 |            |      |        |       |  |     |   |            |   |         |            |
|--|-----------------|------------|------|--------|-------|--|-----|---|------------|---|---------|------------|
| for geothermal projects in Nevada (from Woodford, 2003)  |                 |            |      |        |       |  |     |   |            |   |         |            |
|  | Site substation |            |      |        | Line  |  |     |   |            | Collector/Line substations/taps             |         |            |
| Project  | kV              | \$ million | MW   | \$/kW  | miles | From>To                                  | kV  | \$ million  | \$/mile    | Name  | kV      | \$ million |
| Stage 2 <sup>(a)</sup>   |                 |            |      |        |       |  |     |   |            |   |         |            |
| Fly Ranch  | 115             | \$ 1.3     | 23.5 | \$ 55  | 16    | Fly>Ger                                  | 115 | \$ 2.7  | \$ 168,750 |   |         |            |
| Gerlach  | 115             | \$ 1.5     | 37   | \$ 41  | 10    | Ger>PDCI <sup>4</sup>                    | 115 | \$ 2.2  | \$ 220,000 | PDCI Tap frm Gerlach                        | 115/345 | 9.7        |
| Stage 3 <sup>(b)</sup>   |                 |            |      |        |       |  |     |   |            |   |         |            |
| Lee H.S.   | 115             | \$ 1.3     | 9.5  | \$ 137 | 17    | Lee>Salt W                               | 115 | \$ 3.7  | \$ 217,647 |   |         |            |
| Salt Wells   | 115/345         | \$ 7.8     | 133  | \$ 59  | 10    | Salt W>Fall/Car                          | 345 | \$ 6.7  | \$ 670,000 |   |         |            |
| Fallon/Carson  | 345             | \$ 3.2     | 65   | \$ 49  | 51    | Fall/Car>NV                              | 345 | \$ 19.1   | \$ 374,510 |   |         |            |
| North Valley (NV)  | 345             | \$ 7.2     | 71   | \$ 101 | 27    | NV>Tracy                                 | 345 | \$ 10.1   | \$ 374,074 | Tracy upgrade                               | 345     | 2.7        |
| Hazen  | 115             | \$ 1.3     | 12   | \$ 108 | 19    | Hazen>Eagle                              | 115 | \$ 4.1  | \$ 215,789 | Eagle upgrade                               | 115     | 1.0        |
| Stage 4 <sup>(c)</sup>   |                 |            |      |        |       |  |     |   |            |   |         |            |
| Blue Mtn   | 120             | \$ 1.5     | 32   | \$ 47  | 35    | Blue Mtn > Rye P                         | 120 | \$ 4.7  | \$ 134,286 | Oreana upgrade                              | 120     | 5.2        |
| Rye Patch - Humb. Hse - HH <sup>1</sup>  | 120             | \$ 1.7     | 81   | \$ 21  | 5     | Humb Hse > Rye P                         | 120 | \$ 1.3  | \$ 260,000 |   |         |            |
| Rye Patch - Humb. Hse - RP   |                 |            |      |        | 48    | Rye P > Oreana (2 lines)                 | 120 | \$ 6.4  | \$ 133,333 |   |         |            |
|  |                 |            |      |        |       |  |     |   |            |   |         |            |
| Colado   | 120             | \$ 1.3     | 7    | \$ 186 | 8     | Colado > Oreana                          | 120 | \$ 1.9  | \$ 237,500 |   |         |            |
| New York Canyon (NYC)  | 120             | \$ 1.5     | 36   | \$ 42  | 28    | NYC > Oreana                             | 120 | \$ 3.8  | \$ 135,714 |   |         |            |
| Pumpnickel Valley (PV)   | 120             | \$ 1.3     | 18   | \$ 72  | 65    | PV > Oreana <sup>2</sup>                 | 120 | \$ 8.8  | \$ 135,385 |   |         |            |
| Leach  | 120             | \$ 2.3     | 24   | \$ 96  | 0     | along PV > Oreana                        |     |   |            |   |         |            |
| Kyle H.S.  | 120             | \$ 1.5     | 30   | \$ 50  | 0     | Tap PV > Oreana                          | 120 | \$ 1.5  |            |   |         |            |
|  |                 |            |      |        | 71    | Oreana > North Valley                    | 345 | \$ 26.5   | \$ 373,239 | New Oreana                                  | 120/345 | 20.3       |
| Trinity Mtns.  | 345             | \$ 3.3     | 83   | \$ 40  | 0     | along Oreana > North V <sup>3</sup>      |     |   |            |   |         |            |
|  |                 |            |      |        | 58    | North Valley > PDCI Tap                  | 345 | \$ 21.7   | \$ 374,138 | North Valley upgrade                        | 345     | 7.4        |
| 16 GEOTHERMAL PROJECT AREAS  |                 |            |      |        |       |  |     |   |            | PDCI Tap upgrade (geoth inlet portion only) | 345     | 2.7        |
| Totals/Averages  |                 | \$ 38      | 662  | \$ 57  | 468   | Line                                     |     | \$ 125  | \$ 267,521 | Coll./Ln. subs/taps                         |         | \$ 49      |
| Std.Dev.   |                 |            |      | \$ 44  |       | Line                                     |     |   | \$ 145,418 | Common Line                                 |         |            |
| Totals/Averages  |                 |            |      |        | 468   | Line+Coll./Line subs/taps                |     | \$ 174  | \$ 372,253 | (Oreana >NV>PDCI)                           |         | \$ 48      |
|  |                 |            |      |        | 251   | 115-120 kV Line                          |     | \$ 41.1   | \$ 163,745 | Total                                       |         | \$ 97      |
|  |                 |            |      |        | 217   | 345 kV Line                              |     | \$ 84.1   | \$ 387,558 |   |         |            |
|  |                 |            |      |        | 468   | all Line as 115-120 kV                   |     | \$ 76.6   | \$ 163,745 | Project Line                                |         | \$ 77      |
|  |                 |            |      |        | 468   | Line as 115-20 kV + Coll./Line subs/taps |     | \$ 126  | \$ 268,476 | Total Line + Coll./Ln sub/taps              |         | \$ 174     |
| 1. Split is Humbolt House 51 MW, Rye Patch 30 MW.  |                 |            |      |        |       |  |     | (a) Not including Honey Lake - Alturas 345 kV extension and substations at Honey Lake (345 kV) and Alturas (345 kV) and Capt. Jack A6(345/500 kV) |            |   |         |            |
| 2. Assume that Pumpnickel Valley > Leach is 12 miles, Leach>Kyle is 24 miles and Kyle>Oreana is 29 miles               |                 |            |      |        |       |  |     | (b) Not including Trans Sierra ac transmission line at 500 kV from Honey Lake to Table Mtn.   |            |   |         |            |
| 3. Assume Oreana>Trinity Mtns is 45 miles, and Trinity Mtns>North Valley is 26 miles                                   |                 |            |      |        |       |  |     | (c) Not including 1500 MW +/-500 kV DC Tap at PDCI  |            |   |         |            |
| 4. PDCI is the 1000 kVDC Pacific Inter-tie from Los Angeles north into Oregon.   |                 |            |      |        |       |  |     |   |            |   |         |            |



**Appendix VII**  
**How to Use the Database / Technical Information**



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## **APPENDIX VII**

### **HOW TO USE THE DATABASE / TECHNICAL INFORMATION**

#### **1) DATABASE VERSION**

The PIER Geothermal Database has been designed and created on a computer running Microsoft Windows XP, using Microsoft Access 2002©, with the Access 2000 file format setting. This means that the database should operate properly in Access 2000 or 2002. Users who need a file format compatible with Access 97 should contact GeothermEx (see below), and an Access 97 version can be supplied.

#### **2) SETUP ON HARD DISK**

The database **MUST** be opened into Access from a hard disk. It will not work properly from a CD, but can be copied to a hard disk from a CD.

When the database is copied from the CD to a hard disk, the READ-ONLY attribute of the database file remains set to ON, and it **MUST** be turned OFF. To do this:

- i) Copy the database from the CD to the hard disk.
- ii) Tag the filename (in Windows Explorer or other folder).
- iii) Right-click the mouse button and select Properties.
- iv) Look for the General Tab, and at the bottom there should be Attributes.
- v) Click on Read Only to turn it off, and close the Properties window.

#### **3) REQUIRED VIDEO DISPLAY SETTINGS**

##### **a) Screen Resolution 1280 X 1024**

The database user-interface has been designed for use at a screen resolution of 1280 x 1024 pixels. Video displays at lower resolution may cause some of the interface windows to over-fill the screen and make them awkward to use.

To increase the screen resolution to 1280 x 1024 pixels:

- i) On the Windows Desktop, right click the mouse button. A menu should open up.
- ii) Select Properties. The Display Properties Window should open up.
- iii) Select the Settings tab.
- iv) Drag the Screen Resolution arrow to the right, and stop at 1280 x 1024 (usually the far right).
- v) Click OK.

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b) Font Size and/or DPI Setting

Some users (particularly with older versions of Windows) may find that screen fonts in the database (e.g. on data input screens) are truncated either vertically or horizontally, or command buttons appear to have incomplete captions.

These problems can be related to an inability of Windows and Access to correctly manage one of the Display settings of the Windows desktop, and can be corrected by changing the display font size (all versions of Windows) and/or DPI setting (newer versions only):

- i) Right click on the Windows desktop
- ii) Select in sequence:
  - (1) Properties (a menu option)
  - (2) Settings (a tab)
  - (3) Advanced (a button on the Settings tab)
  - (4) General (a tab on a video properties window)
- iii) At this point, the General tab will show a pull-down list of options that says either:
  - (1) Display Font Size (older versions of Windows) - Choose Large Fonts
  - or
  - (2) DPI Setting (newer versions of Windows) - Choose Large Size (120 DPI)
- iv) Select OK or Apply, and re-boot

If the formatting problem remains, it may be necessary to change the Display Font Size setting that alternatively appears under Properties (menu option) Appearance (tab). The database has been designed with "Normal" size.

If there are additional formatting problems, please contact GeothermEx (see below)

### **4) DATABASE FIGURES AND DOCUMENTS DISPLAY**

The database includes figures and some documents as embedded Adobe Acrobat .pdf files. Be aware of the following:

- a) A .pdf file is opened by double-clicking on the icon that represents in a database figure list or report.
- b) The user's computer must have the Acrobat reader installed.
- c) Most (not all) of these .pdf files are programmed to open in "Full screen mode", i.e. the Acrobat window frame and menus are hidden.

## **Hetch Hetchy/SFPUC Programmatic Renewable Energy Project**

**Project: 1.3 New Geothermal Site Identification and Qualification**

**Project Team: GeothermEx, Inc.**

**Task: 1.3.10 Final Project Report**

**Subject: Deliverable 1.3.10.3 Final Report**

- d) To close the figure (i.e., the .pdf), hit Esc. This causes it to revert to the Acrobat window. Once in the Acrobat window, the figure can be closed by closing it (closing the .pdf file) or closing Acrobat, or it can be zoomed to see fine detail, printed, etc..
- e) Interactions between Access, Windows and Acrobat are imperfect, and double-clicking the .pdf icon in Access occasionally produces a blank screen, or a blank document in the Acrobat window.
- f) In such cases, it has been found sufficient to close the Acrobat screen or document (use the Esc key and close the .pdf or close Acrobat), then re-load the .pdf from Access by again double-clicking on the .pdf icon.

### **5) STRUCTURE OF THE DATABASE**

The database comprises a set of:

- a) Tables which contain data and information,
- b) Forms for viewing the data,
- c) Reports that generate detailed or summary lists of the data on screen and/or to a printer,
- d) Queries that extract the data for the Forms and Reports (see below),
- e) Modules (essentially hidden from the user) that contain code, and
- f) Figures and Documents, which are stored in Adobe Acrobat (.pdf) format and embedded into the database as "OLE" objects.

There are also hidden Relationships which link the data tables.

The Tables, Forms, Reports, Figures, Documents and some of the Queries are accessed via the Database Startup Form, as follows.

### **6) USING THE DATABASE**

- a) When the database is opened in Access, the user is presented with a window entitled "PIER Public Renewable Partnership Geothermal Database Startup" (Figure 2). This has command buttons:
  - i) View Projects Data and Figures - puts the user into the Projects window, from which the data for individual projects can be viewed in a set of different forms, project figures can be accessed, reports for the currently displayed project can be generated, and certain other reports and queries can be generated.

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Move from one project to another by using the Page Up and Page Down keys, or by using the Projects List under “Choose Project” at upper left (see further help at the list box). Each project has a unique Project ID number, which serves to establish its unique identity.

- ii) Preview and Print Reports and Documents - puts the user directly into a window from which pre-formatted Reports and Documents can be generated or viewed. A button in the Projects window (“Multi-Project Reports & Documents”) also accesses this reports window.

Some reports prompt the user to specify which project(s) are to be included, using the Project ID number. It is possible to enter a single project (e.g. AUR00), or a set of related projects using wildcards (e.g. LVM\*)

### **7) ABOUT QUERIES, EXPORTING DATA AND USING ADVANCED FEATURES OF ACCESS**

A Query is a structured command that extracts information from a database according to the criteria written into the query. The information gets extracted into a table viewed on screen, or in background mode into a report or form that displays data on-screen or to a printer. Most of the queries in this database are hidden from the casual user, but can be accessed as described below. One query is made available via a button on the Projects window (“Query Main Facts”). This displays a large amount of basic information from the database in a simple tabular format that is suitable for export to MS Excel. Instructions for doing this are given at the adjacent help (“?”) button.

Data can also be exported from any Database Report into MS Excel or MS Word by displaying the report on-screen and selecting Tools/Office Links from the main menu. This process successfully transfers data and variable names, but will not completely transfer all of the information in column headings that have a complex format.

If the user who is familiar with Access desires to further explore the project data using more complicated queries, the normal Access database window (all tables, forms, queries, macros, modules, etc.) can be obtained as follows:

- i) close the Database Startup Form but do not close Access.
- ii) re-open the database via the File pull-down on the Access main menu, by selecting the database name at the top of the “most recently used” list at the bottom of the File menu.

GeothermEx, Inc.

510-527-9876

e-mail mw@geothermex.com. Put “Attn: Chris Klein” in the Subject line.

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***Table 1: Projects List***

| <i>PROJID</i> | <i>Name:<br/>Field/District</i> | <i>Name:<br/>Area/Power Plant</i> | <i>KGRA</i>       | <i>Area</i> <sup>(1)</sup> | <i>State</i> | <i>County</i> | <i>Lat</i> | <i>Long</i> | <i>Expl-Dev.<br/>Cat. (2)</i> | <i>Gen.Cap.<br/>Estimated</i> |
|---------------|---------------------------------|-----------------------------------|-------------------|----------------------------|--------------|---------------|------------|-------------|-------------------------------|-------------------------------|
| ADO00         | Adobe Valley                    | (Granite Springs V. - N. End)     |                   | 1                          | NV           | Pershing      | 40.22      | 118.92      | D                             | N                             |
| ANT00         | Antelope Valley                 |                                   |                   | 3                          | NV           | Churchill     | 39.83      | 117.50      | D                             | N                             |
| AUR00         | Aurora                          |                                   |                   | 2                          | NV           | Mineral       | 38.35      | 118.82      | C                             | Y                             |
| BAL00         | Baltazor                        |                                   | Baltazor          | 3                          | NV           | Humboldt      | 41.92      | 118.72      | C                             | Y                             |
| BAT00         | Battle Mountain                 |                                   |                   | 1                          | NV           | Humboldt      | 40.77      | 117.21      | D                             | N                             |
| BEO00         | Beowawe                         |                                   | Beowawe           | 1                          | NV           | Eureka-Lander | 40.55      | 113.62      | A                             | Y                             |
| BIG00         | Big Smokey Valley               | N.End - Spencer Hot Springs       |                   | 3                          | NV           | Lander        | 39.33      | 116.83      | D                             | N                             |
| BLA00         | Black Rock Desert               |                                   |                   | 1                          | NV           | Humboldt      |            |             |                               | N                             |
| BLU00         | Blue Mountain                   |                                   |                   | 1                          | NV           | Humboldt      | 41.00      | 118.13      | C                             | Y                             |
| BOD00         | Bodie                           |                                   | Bodie             | 4                          | CA           | Mono          | 38.16      | 119.11      | D                             | N                             |
| BRA00         | Brady's Hot Springs             |                                   | Brady-Hazen       | 1                          | NV           | Churchill     | 39.80      | 119.00      | A                             | Y                             |
| BRW00         | Brawley                         | Area-wide summary                 | Brawley           | 4                          | CA           | Imperial      | 32.99      | 115.52      | B                             | N                             |
| BRW01         | Brawley                         | Brawley (North Brawley)           | Brawley           | 4                          | CA           | Imperial      | 33.00      | 115.53      | B                             | Y                             |
| BRW02         | Brawley                         | East Brawley                      |                   | 4                          | CA           | Imperial      | 32.99      | 115.35      | B                             | Y                             |
| BRW03         | Brawley                         | South Brawley (Mesquite field)    |                   | 4                          | CA           | Imperial      | 32.96      | 115.54      | B                             | Y                             |
| CAL00         | Calistoga                       |                                   | Geysers-Calistoga | 4                          | CA           | Napa          | 38.58      | 122.58      | C                             | Y                             |
| CAR00         | Carson Sink                     |                                   |                   | 1                          | NV           | Churchill     |            |             | D                             | N                             |
| COL00         | Colado                          |                                   | Colado            | 1                          | NV           | Pershing      | 40.23      | 118.37      | C                             | Y                             |
| COS00         | Coso                            | Field-wide Summary                | Coso Hot Springs  | 4                          | CA           | Inyo          | 36.03      | 117.80      | A                             | Y                             |

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|---------------|---------------------------------|---------------------------------------|----------------------|----------------------------|--------------|---------------|------------|-------------|-------------------------------|-------------------------------|
| COS01         | Coso                            | Navy I                                | Coso Hot Springs     | 4                          | CA           | Inyo          | 36.03      | 117.80      | A                             | N                             |
| COS02         | Coso                            | Navy II                               | Coso Hot Springs     | 4                          | CA           | Inyo          | 36.03      | 117.80      | A                             | N                             |
| COS03         | Coso                            | BLM                                   | Coso Hot Springs     | 4                          | CA           | Inyo          | 36.03      | 117.80      | A                             | N                             |
| COS04         | Coso                            | Northeast frontier                    | Coso Hot Springs     | 4                          | CA           | Inyo          | 36.03      | 117.80      | D                             | N                             |
| DAR00         | Darrough Hot Springs            | (Big Smokey Valley - S.End)           | Darrough Hot Springs | 3                          | NV           | Nye           | 38.82      | 117.18      | C                             | N                             |
| DES00         | Desert Peak                     |                                       | Brady-Hazen          | 1                          | NV           | Churchill     | 39.76      | 118.92      | A                             | Y                             |
| DIX00         | Dixie Valley                    | Caithness Dixie Valley                | Dixie Valley         | 2                          | NV           | Churchill     | 39.99      | 117.85      | A                             | Y                             |
| DIX01         | Dixie Valley                    | Dixie Valley Power Partners<br>(DVPP) |                      | 2                          | NV           | Churchill     | 39.99      | 117.85      | C                             | Y                             |
| DOU00         | Double - Black Rk Hot Springs   |                                       | Double Hot Springs   | 3                          | NV           | Humboldt      | 41.05      | 119.03      | D                             | Y                             |
| DRY00         | Dry Lake                        |                                       |                      | 1                          | NV           | Pershing      | 39.37      | 116.83      | D                             | N                             |
| DUN00         | Dunes                           |                                       | Dunes                | 4                          | CA           | Imperial      | 32.80      | 115.01      | C                             | Y                             |
| DYK00         | Dyke Hot Springs                |                                       |                      | 3                          | NV           | Humboldt      | 41.57      | 118.57      | D                             | N                             |
| EAS00         | East Mesa                       | Field-wide summary                    | East Mesa            | 4                          | CA           | Imperial      | 32.78      | 115.25      | A                             | Y                             |
| EAS01         | East Mesa                       | Ormesa 1                              | East Mesa            | 4                          | CA           | Imperial      | 32.78      | 115.25      | A                             | N                             |
| EAS02         | East Mesa                       | Ormesa 1E                             | East Mesa            | 4                          | CA           | Imperial      | 32.78      | 115.25      | A                             | N                             |
| EAS03         | East Mesa                       | Ormesa 1H                             |                      | 4                          | CA           | Imperial      | 32.78      | 115.25      | A                             | N                             |
| EAS04         | East Mesa                       | Ormesa 2 (or II)                      | East Mesa            | 4                          | CA           | Imperial      | 32.78      | 115.25      | A                             | N                             |
| EAS05         | East Mesa                       | Geo East Mesa (GEM) I                 | East Mesa            | 4                          | CA           | Imperial      | 32.78      | 115.25      | A                             | N                             |
| EAS06         | East Mesa                       | Geo East Mesa (GEM) 2-3               | East Mesa            | 4                          | CA           | Imperial      | 32.78      | 115.25      | A                             | N                             |
| ELE00         | Eleven Mile Canyon              |                                       |                      | 2                          | NV           | Churchill     | 39.42      | 118.24      |                               | N                             |
| EMI00         | Emigrant (Fish Lake V.)         |                                       |                      | 2                          | NV           | Esmeralda     | 37.86      | 117.87      | C                             | Y                             |
| EMP00         | Empire (San Emidio)             | Field-wide summary                    | San Emidio Desert    | 1                          | NV           | Washoe        | 40.38      | 119.40      | A                             | Y                             |
| EMP01         | Empire (San Emidio)             | Empire Energy                         | San Emidio Desert    | 1                          | NV           | Washoe        | 40.38      | 119.40      | A                             | N                             |
| EMP02         | Empire (San Emidio)             | Empire Foods                          | San Emidio Desert    | 1                          | NV           | Washoe        | 40.38      | 119.40      | B                             | N                             |
| EXC00         | Excelsior                       |                                       |                      | 2                          | NV           | Mineral       | 38.31      | 118.56      |                               | N                             |
| FAL00         | Fallon / Carson Lake            | Carson Lake anomaly                   |                      | 1                          | NV           | Churchill     | 39.38      | 118.65      | C                             | Y                             |

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|---------------|---------------------------------|-----------------------------------|-------------------|----------------------------|--------------|---------------------|------------|-------------|-------------------------------|-------------------------------|
| FAL01         | Fallon / Carson Lake            | Fallon Naval Air Station          |                   | 1                          | NV           | Churchill           | 39.38      | 118.65      | C                             | N                             |
| FIR00         | Fireball Ridge                  |                                   |                   | 1                          | NV           | Churchill           | 39.92      | 119.07      | D                             | N                             |
| FIS00         | Fish Lake (Valley)              |                                   |                   | 2                          | NV           | Esmeralda           | 37.86      | 118.05      | B                             | Y                             |
| FLY00         | Fly Ranch/Granite Ranch         | Ward's (Fly/Hualapi Flat)<br>H.S. | Fly Ranch         | 1                          | NV           | Washoe-<br>Pershing | 40.86      | 119.32      | C                             | Y                             |
| FLY01         | Fly Ranch/Granite Ranch         | Granite Ranch                     |                   | 1                          | NV           | Washoe-<br>Pershing | 40.86      | 119.32      | C                             | Y                             |
| FOX00         | Fox Mountain                    |                                   |                   | 3                          | NV           | Washoe              | 41.02      | 119.56      | C                             | N                             |
| GER00         | Gerlach                         | (Great Boiling Spring)            | Gerlach           | 1                          | NV           | Washoe              | 40.66      | 119.37      | C                             | Y                             |
| GEY00         | Geysers                         | Field-wide Summary                | Geysers/Calistoga | 4                          | CA           | Lake-<br>Sonoma     | 38.8       | 122.75      | A                             | Y                             |
| GEY01         | Geysers                         | McCabe (Units 5 & 6)              | Geysers-Calistoga | 4                          | CA           | Sonoma              |            |             | A                             | N                             |
| GEY02         | Geysers                         | Ridgeline (Units 7 & 8)           | Geysers-Calistoga | 4                          | CA           | Sonoma              |            |             | A                             | N                             |
| GEY03         | Geysers                         | Fumarole (Units 9 & 10)           | Geysers-Calistoga | 4                          | CA           | Sonoma              |            |             | A                             | N                             |
| GEY04         | Geysers                         | Eagle Rock (Unit 11)              | Geysers-Calistoga | 4                          | CA           | Sonoma<br>and Lake  |            |             | A                             | N                             |
| GEY05         | Geysers                         | Cobb Creek (Unit 12)              | Geysers-Calistoga | 4                          | CA           | Sonoma              |            |             | A                             | N                             |
| GEY06         | Geysers                         | Big Geysers (Unit 13)             | Geysers-Calistoga | 4                          | CA           | Sonoma<br>and Lake  |            |             | A                             | N                             |
| GEY07         | Geysers                         | Sulphur Springs (Unit 14)         | Geysers-Calistoga | 4                          | CA           | Sonoma              |            |             | A                             | N                             |
| GEY08         | Geysers                         | Lake View (Unit 17)               | Geysers-Calistoga | 4                          | CA           | Sonoma<br>and Lake  |            |             | A                             | N                             |
| GEY09         | Geysers                         | NCPA 1 & 2                        | Geysers-Calistoga | 4                          | CA           | Sonoma<br>and Lake  |            |             | A                             | N                             |
| GEY10         | Geysers                         | Socrates (Unit 18)                | Geysers-Calistoga | 4                          | CA           | Sonoma<br>and Lake  |            |             | A                             | N                             |
| GEY11         | Geysers                         | Sonoma (SMUDGE0)                  | Geysers-Calistoga | 4                          | CA           | Sonoma<br>and Lake  |            |             | A                             | N                             |
| GEY12         | Geysers                         | Calistoga                         | Geysers-Calistoga | 4                          | CA           | Sonoma<br>and Lake  |            |             | A                             | N                             |
| GEY13         | Geysers                         | Quicksilver (Unit 16)             | Geysers-Calistoga | 4                          | CA           | Lake                |            |             | A                             | N                             |

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|---------------|---------------------------------|-----------------------------------|---------------------------|----------------------------|--------------|--------------------|------------|-------------|-------------------------------|-------------------------------|
| GEY14         | Geysers                         | Grant (Unit 20)                   | Geysers-Calistoga         | 4                          | CA           | Sonoma             |            |             | A                             | N                             |
| GEY15         | Geysers                         | NCPA 3 & 4                        | Geysers-Calistoga         | 4                          | CA           | Sonoma<br>and Lake |            |             | A                             | N                             |
| GEY16         | Geysers                         | Bear Canyon                       | Geysers-Calistoga         | 4                          | CA           | Lake               |            |             | A                             | N                             |
| GEY17         | Geysers                         | West Ford Flat                    | Geysers-Calistoga         | 4                          | CA           | Lake               |            |             | A                             | N                             |
| GEY18         | Geysers                         | Aidlin                            | Geysers-Calistoga         | 4                          | CA           | Sonoma             |            |             | A                             | N                             |
| GEY19         | Geysers                         | Unit 15                           | Geysers-Calistoga         | 4                          |              | Sonoma             |            |             | B                             | N                             |
| GLA00         | Glamis                          |                                   | Glamis                    | 4                          | CA           | Imperial           | 32.97      | 115.04      | D                             | Y                             |
| GRA00         | Grass Valley                    | (Little Hot Springs)              |                           | 3                          | NV           | Lander             | 39.89      | 116.65      |                               | N                             |
| HAW00         | Hawthorne                       |                                   |                           | 2                          | NV           | Mineral            | 38.53      | 118.65      | C                             | Y                             |
| HAZ00         | Hazen (Black Butte)             | (Patua Hot Springs)               | Brady-Hazen (S end of)    | 1                          | NV           | Lyon               | 39.6       | 119.11      | C                             | Y                             |
| HEB00         | Heber                           | Field-wide Summary                | Heber                     | 4                          | CA           | Imperial           | 32.72      | 115.53      | A                             | Y                             |
| HEB01         | Heber                           | Heber (HGC)                       | Heber                     | 4                          | CA           | Imperial           | 32.72      | 115.53      | A                             | N                             |
| HEB02         | Heber                           | Second Imperial Geoth.<br>(SIGC)  | Heber                     | 4                          | CA           | Imperial           | 32.72      | 115.53      | A                             | N                             |
| HON00         | Honey Lake                      | Area-wide Summary                 | Wendel-Amedee             | 1                          | CA           | Lassen             | 40.33      | 120.20      | A                             | Y                             |
| HON01         | Honey Lake                      | Amedee                            | Wendel-Amedee             | 1                          | CA           | Lassen             | 40.30      | 120.20      | A                             | N                             |
| HON02         | Honey Lake                      | Wendel/Wineagle                   | Wendel-Amedee             | 1                          | CA           | Lassen             | 40.35      | 120.25      | A                             | N                             |
| HON03         | Honey Lake                      | Wendel/Honey Lake Power           | Wendel-Amedee             | 1                          | CA           | Lassen             | 40.37      | 120.25      | A                             | N                             |
| HSS00         | Hot Sulphur Springs             | (Independence V./Tuscarora)       |                           | 3                          | NV           | Elko               | 41.47      | 116.15      | C                             | N                             |
| HYD00         | Hyder Hot Springs               |                                   | Dixie Valley              | 2                          | NV           | Pershing           | 39.99      | 117.71      | D                             | Y                             |
| KYL00         | Kyle Hot Springs (Granite Mtn.) | (Buena Vista Valley)              |                           | 1                          | NV           | Pershing           | 40.41      | 117.89      | C                             | Y                             |
| LAK00         | Lake City / Surprise Valley     | Lake City                         | Lake City-Surprise Valley | 4                          | CA           | Modoc              | 41.67      | 120.22      | B                             | Y                             |
| LEA00         | Leach Hot Springs               | Grass Valley                      | Leach Hot Springs         | 1                          | NV           | Pershing           | 40.60      | 117.65      | C                             | Y                             |
| LEE00         | Lee Hot Springs                 |                                   |                           | 1                          | NV           | Churchill          | 39.21      | 118.72      | C                             | Y                             |
| LOC00         | Lockwood                        |                                   |                           | 1                          | NV           | Washoe             | 39.51      | 119.65      |                               | N                             |
| LVC00         | Long Valley - Casa Diablo       | MP Field Summary                  | Mono-Long Valley          | 4                          | CA           | Mono               | 37.65      | 118.90      | A                             | N                             |
| LVC01         | Long Valley - Casa Diablo       | Mammoth-Pacific G1(MP-1)          | Mono-Long Valley          | 4                          | CA           | Mono               | 37.65      | 118.90      | A                             | N                             |

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|---------------|-----------------------------------|-----------------------------------|-------------------|----------------------------|--------------|------------------|------------|-------------|-------------------------------|-------------------------------|
| LVC02         | Long Valley - Casa Diablo         | Mammoth-Pacific G2(MP-2)          | Mono-Long Valley  | 4                          | CA           | Mono             | 37.65      | 118.90      | A                             | N                             |
| LVC03         | Long Valley - Casa Diablo         | Mammoth-Pacific G3(PLES-1)        | Mono-Long Valley  | 4                          | CA           | Mono             | 37.65      | 118.90      | A                             | N                             |
| LVM00         | Long Valley - M-P Leases          | M-P Lease Summary                 | Mono-Long Valley  | 4                          | CA           | Mono             | 37.65      | 118.90      | A                             | Y                             |
| LVM01         | Long Valley - M-P Leases          | Basalt Canyon Expl. Project       | Mono-Long Valley  | 4                          | CA           | Mono             | 37.65      | 118.90      | C                             | N                             |
| LVM02         | Long Valley - M-P Leases          | Upper Basalt Canyon Expl. Project | Mono-Long Valley  | 4                          | CA           | Mono             | 37.65      | 118.90      | C                             | N                             |
| LVM03         | Long Valley - M-P Leases          | Rhyolite Plateau Exploration Area | Mono-Long Valley  | 4                          | CA           | Mono             | 37.65      | 118.90      | C                             | N                             |
| MCF00         | McFarlanes Hot Spring             | (Black Rock Desert)               |                   | 1                          | NV           | Humboldt         | 41.08      | 118.69      | D                             | N                             |
| MCG00         | McGee Mountain                    | (Painted Hills)                   |                   | 3                          | NV           | Humboldt         | 41.80      | 118.87      | C                             | Y                             |
| MED00         | Medicine Lake                     | Field-wide Summary                | Glass Mountain    | 4                          | CA           | Siskiyou         | 41.58      | 121.6       | B                             | N                             |
| MED01         | Medicine Lake                     | Fourmile Hill                     | Glass Mountain    | 4                          | CA           | Siskiyou         | 41.63      | 121.63      | B                             | Y                             |
| MED02         | Medicine Lake                     | Telephone Flat                    | Glass Mountain    | 4                          | CA           | Siskiyou         | 41.57      | 121.57      | B                             | Y                             |
| MED03         | Medicine Lake                     | Pumice Mine Prospect              | Glass Mountain    | 4                          | CA           | Siskiyou         |            |             | D                             | N                             |
| MOS00         | Mount Signal                      |                                   |                   | 4                          | CA           | Imperial         | 32.65      | 115.71      | C                             | Y                             |
| NEW00         | New York Canyon                   |                                   |                   | 1                          | NV           | Pershing         | 40.05      | 118.00      | C                             | Y                             |
| NIL00         | Niland                            |                                   |                   | 4                          | CA           | Imperial         | 33.22      | 115.54      | B                             | Y                             |
| NOR00         | North Valley                      |                                   |                   | 1                          | NV           | Churchill-Washoe | 39.90      | 119.22      | C                             | Y                             |
| PIN00         | Pinto Hot Springs                 |                                   | Pinto Hot Springs | 3                          | NV           | Humboldt         | 41.36      | 118.80      | D                             | Y                             |
| PIR00         | Pirouette Mountain                | (S.Dixie Valley)                  |                   | 2                          | NV           | Churchill        | 39.51      | 118.16      | D                             | Y                             |
| PUM00         | Pumpnickel Valley                 | Tipton Ranch/Hot Springs Ranch    |                   | 1                          | NV           | Humboldt         | 40.76      | 117.49      | C                             | Y                             |
| PYR00         | Pyramid Lake Indian Reserv.       | (Needle Rocks Hot Springs)        |                   | 1                          | NV           | Washoe           | 40.15      | 119.68      | C                             | Y                             |
| RAN00         | Randsburg                         |                                   | Randsburg         | 4                          | CA           | San Bernardino   | 35.38      | 117.53      | C                             | Y                             |
| ROS00         | Rose Creek                        |                                   |                   | 1                          | NV           | Pershing(?)      | 40.84      | 117.95      | D                             | N                             |
| RYE00         | Rye Patch-Humboldt House District | Field-wide summary                | Rye Patch         | 1                          | NV           | Pershing         | 40.53      | 118.27      | B                             | N                             |

| <i>PROJID</i> | <i>Name:<br/>Field/District</i>   | <i>Name:<br/>Area/Power Plant</i> | <i>KGRA</i>          | <i>Area</i> <sup>(1)</sup> | <i>State</i> | <i>County</i> | <i>Lat</i> | <i>Long</i> | <i>Expl-Dev.<br/>Cat. (2)</i> | <i>Gen.Cap.<br/>Estimated</i> |
|---------------|-----------------------------------|-----------------------------------|----------------------|----------------------------|--------------|---------------|------------|-------------|-------------------------------|-------------------------------|
| RYE01         | Rye Patch-Humboldt House District | Rye Patch                         | Rye Patch            | 1                          | NV           | Pershing      | 40.53      | 118.27      | B                             | Y                             |
| RYE02         | Rye Patch-Humboldt House District | Humboldt House                    | Rye Patch            | 1                          | NV           | Pershing      | 40.53      | 118.27      | C                             | Y                             |
| SAI00         | Saline Valley                     |                                   | Saline Valley        | 4                          | CA           | Inyo          | 36.79      | 117.76      | D                             | N                             |
| SAL00         | Salton Sea                        | Field-wide summary                | Salton Sea           | 4                          | CA           | Imperial      | 33.17      | 115.62      | A                             | Y                             |
| SAL01         | Salton Sea                        | Unit 1                            | Salton Sea           | 4                          | CA           | Imperial      | 33.17      | 115.62      | A                             | N                             |
| SAL02         | Salton Sea                        | Unit 2                            | Salton Sea           | 4                          | CA           | Imperial      | 33.17      | 115.62      | A                             | N                             |
| SAL03         | Salton Sea                        | Unit 3                            | Salton Sea           | 4                          | CA           | Imperial      | 33.17      | 115.62      | A                             | N                             |
| SAL04         | Salton Sea                        | Unit 4                            | Salton Sea           | 4                          | CA           | Imperial      | 33.17      | 115.62      | A                             | N                             |
| SAL05         | Salton Sea                        | Unit 5                            | Salton Sea           | 4                          | CA           | Imperial      | 33.17      | 115.62      | A                             | N                             |
| SAL06         | Salton Sea                        | Unit 6                            | Salton Sea           | 4                          | CA           | Imperial      | 33.17      | 115.62      | B                             | N                             |
| SAL07         | Salton Sea                        | Vulcan                            | Salton Sea           | 4                          | CA           | Imperial      | 33.17      | 115.62      | A                             | N                             |
| SAL08         | Salton Sea                        | Del Ranch (Hoch)                  | Salton Sea           | 4                          | CA           | Imperial      | 33.17      | 115.62      | A                             | N                             |
| SAL09         | Salton Sea                        | Elmore                            | Salton Sea           | 4                          | CA           | Imperial      | 33.17      | 115.62      | A                             | N                             |
| SAL10         | Salton Sea                        | Leathers                          | Salton Sea           | 4                          | CA           | Imperial      | 33.17      | 115.62      | A                             | N                             |
| SAL11         | Salton Sea                        | Vulcan/Hoch Turboexpander         | Salton Sea           | 4                          | CA           | Imperial      | 33.17      | 115.62      | A                             | N                             |
| SAW00         | Salt Wells                        | Eight Mile Flat                   |                      | 1                          | NV           | Churchill     | 39.31      | 118.57      | C                             | Y                             |
| SES00         | Sespe Hot Springs                 |                                   | Sespe Hot Springs    | 4                          | CA           | Ventura       | 34.60      | 119.00      | D                             | Y                             |
| SHO00         | Shoshone-Reese River              |                                   |                      | 3                          | NV           | Lander        | 39.89      | 117.14      | D                             | Y                             |
| SIL00         | Silver Peak                       | (Alum prospect)                   |                      | 2                          | NV           | Esmeralda     | 37.91      | 117.67      | C                             | Y                             |
| SOD00         | Soda Lake                         | Soda Lake No.1/No.2               | Stillwater-Soda Lake | 1                          | NV           | Churchill     | 39.55      | 118.87      | A                             | Y                             |
| SOH00         | Sou Hot Springs                   | (Seven Devils/Gilbert's H.S.)     | Dixie Valley         | 2                          | NV           | Pershing      | 40.08      | 117.72      | D                             | Y                             |
| SOU00         | Southern Pacific                  |                                   |                      | 1                          | NV           | Churchill(?)  | 40.06      | 118.89      | D                             | N                             |
| STE00         | Steamboat Hot Sprs                | Field-wide Summary                | Steamboat Springs    | 1                          | NV           | Washoe        | 39.38      | 117.76      | A                             | Y                             |
| STE01         | Steamboat Hot Sprs                | Lower SB: Steamboat I-1A          | Steamboat Springs    | 1                          | NV           | Washoe        | 39.38      | 117.76      | A                             | N                             |
| STE02         | Steamboat Hot Sprs                | Lower SB: Steamboat II-III        | Steamboat Springs    | 1                          | NV           | Washoe        | 39.38      | 117.76      | A                             | N                             |
| STE03         | Steamboat Hot Sprs                | Lower SB: Steamboat IV            | Steamboat Springs    | 1                          | NV           | Washoe        | 39.38      | 117.76      | B                             | N                             |

| <i>PROJID</i> | <i>Name:<br/>Field/District</i> | <i>Name:<br/>Area/Power Plant</i> | <i>KGRA</i>              | <i>Area</i> <sup>(1)</sup> | <i>State</i> | <i>County</i>                | <i>Lat</i> | <i>Long</i> | <i>Expl-Dev.<br/>Cat. (2)</i> | <i>Gen.Cap.<br/>Estimated</i> |
|---------------|---------------------------------|-----------------------------------|--------------------------|----------------------------|--------------|------------------------------|------------|-------------|-------------------------------|-------------------------------|
| STE04         | Steamboat Hot Sprs              | Lower SB: UNV Redfield Utility    | Steamboat Springs        | 1                          | NV           | Washoe                       | 39.38      | 117.76      | D                             | N                             |
| STE05         | Steamboat Hot Sprs              | Upper SB: Yankee-Caithness        | Steamboat Springs        | 1                          | NV           | Washoe                       | 39.38      | 117.76      | A                             | N                             |
| STI00         | Stillwater                      | Stillwater Geothermal 1           | Stillwater-Soda Lake     | 1                          | NV           | Churchill                    | 39.55      | 118.55      | A                             | Y                             |
| STI01         | Stillwater                      | Stillwater N Expansion            | Stillwater-Soda Lake     | 1                          | NV           | Churchill                    | 39.55      | 118.55      | B                             | Y                             |
| SUL00         | Sulphur Bank                    | Clear Lake                        | Geysers/Calistoga        | 4                          | CA           | Lake                         | 39.00      | 122.66      | B                             | Y                             |
| SUP00         | Superstition Mountain           |                                   |                          | 4                          | CA           | Imperial                     | 32.95      | 115.80      | D                             | Y                             |
| TRA00         | Tracy                           |                                   |                          | 1                          | NV           | Washoe                       | 39.57      | 119.53      | D                             | N                             |
| TRI00         | Trinity Mountains District      | Telephone Well area               |                          | 1                          | NV           | Church.-<br>Persh.-<br>Wash. | 40.00      | 118.99      | D                             | Y                             |
| TRU00         | Truckhaven                      |                                   |                          | 4                          | CA           | Imperial                     | 33.26      | 116.00      | C                             | N                             |
| TRU01         | Truckhaven                      |                                   |                          | 4                          | CA           | Imperial                     | 33.26      | 116.00      | C                             | N                             |
| VIR00         | Virginia Range                  |                                   |                          | 1                          | NV           | Washoe                       | 39.42      | 119.66      |                               | N                             |
| WAB00         | Wabuska                         |                                   |                          | 1                          | NV           | Lyon                         | 39.16      | 118.18      | A                             | Y                             |
| WES00         | Westmorland                     |                                   | Westmorland - Salton Sea | 4                          | CA           | Imperial                     | 33.08      | 115.65      | C                             | N                             |
| WIL00         | Wilson Hot Springs              |                                   | Wilson Hot Springs       | 3                          | NV           | Lyon                         | 38.77      | 119.18      | D                             | Y                             |

**(1) Geographic Areas:**

**Area 1 – Greater Reno, Nevada (includes California locations)**

**Area 2 – Nevada sites with direct access to the California grid, excluding Greater Reno**

**Area 3 – Other Nevada locations**

**Area 4 – All other California**

**(2) Exploration-Development Categories:**

**A – Existing power plant operating**

**B – One or more wells tested at  $\geq 1$  MW (no power plant in operation)**

**C – Minimum 212°F logged downhole (no well tests at  $\geq 1$  MW)**

**D – Other exploration data and information available ( $\geq 212^\circ\text{F}$  not proven)**

**No category assigned – area does not meet the minimum criteria (see Final Report section 2.2)**



**Hetch Hetchy/SFPUC Programmatic Renewable Energy Project**  
**Project: 1.3 New Geothermal Site Identification and Qualification**  
**Project Team: GeothermEx, Inc.**  
**Task: 1.3.10 Final Project Report**  
**Subject: D.1.3.10.3 Final Report**

**Table 2: Projects by Area**

| <i>PROJID</i>                             | <i>Name:<br/>Field/District</i> | <i>Name:<br/>Area/Power Plant</i> | <i>KGRA</i>       | <i>Area</i> <sup>(1)</sup> | <i>State</i> | <i>County</i>   | <i>Lat</i> | <i>Long</i> | <i>Expl-Dev.<br/>Cat. (2)</i> | <i>Gen.Cap.<br/>Estimated</i> |
|---|---------------------------------|-----------------------------------|-------------------|----------------------------|--------------|-----------------|------------|-------------|-------------------------------|-------------------------------|
| <b>Area: 1 - Greater Reno (NV and CA)</b> |                                 |                                   |                   |                            |              |                 |            |             |                               |                               |
| ADO00                                     | Adobe Valley                    | (Granite Springs V. - N. End)     |                   | 1                          | NV           | Pershing        | 40.22      | 118.92      | D                             | N                             |
| BAT00                                     | Battle Mountain                 |                                   |                   | 1                          | NV           | Humboldt        | 40.77      | 117.21      | D                             | N                             |
| BEO00                                     | Beowawe                         |                                   | Beowawe           | 1                          | NV           | Eureka-Lander   | 40.55      | 113.62      | A                             | Y                             |
| BLA00                                     | Black Rock Desert               |                                   |                   | 1                          | NV           | Humboldt        |            |             |                               | N                             |
| BLU00                                     | Blue Mountain                   |                                   |                   | 1                          | NV           | Humboldt        | 41.00      | 118.13      | C                             | Y                             |
| BRA00                                     | Brady's Hot Springs             |                                   | Brady-Hazen       | 1                          | NV           | Churchill       | 39.80      | 119.00      | A                             | Y                             |
| CAR00                                     | Carson Sink                     |                                   |                   | 1                          | NV           | Churchill       |            |             | D                             | N                             |
| COL00                                     | Colado                          |                                   | Colado            | 1                          | NV           | Pershing        | 40.23      | 118.37      | C                             | Y                             |
| DES00                                     | Desert Peak                     |                                   | Brady-Hazen       | 1                          | NV           | Churchill       | 39.76      | 118.92      | A                             | Y                             |
| DRY00                                     | Dry Lake                        |                                   |                   | 1                          | NV           | Pershing        | 39.37      | 116.83      | D                             | N                             |
| EMP00                                     | Empire (San Emidio)             | Field-wide summary                | San Emidio Desert | 1                          | NV           | Washoe          | 40.38      | 119.40      | A                             | Y                             |
| EMP01                                     | Empire (San Emidio)             | Empire Energy                     | San Emidio Desert | 1                          | NV           | Washoe          | 40.38      | 119.40      | A                             | N                             |
| EMP02                                     | Empire (San Emidio)             | Empire Foods                      | San Emidio Desert | 1                          | NV           | Washoe          | 40.38      | 119.40      | B                             | N                             |
| FAL00                                     | Fallon / Carson Lake            | Carson Lake anomaly               |                   | 1                          | NV           | Churchill       | 39.38      | 118.65      | C                             | Y                             |
| FAL01                                     | Fallon / Carson Lake            | Fallon Naval Air Station          |                   | 1                          | NV           | Churchill       | 39.38      | 118.65      | C                             | N                             |
| FIR00                                     | Fireball Ridge                  |                                   |                   | 1                          | NV           | Churchill       | 39.92      | 119.07      | D                             | N                             |
| FLY00                                     | Fly Ranch/Granite Ranch         | Ward's (Fly/Hualapi Flat) H.S.    | Fly Ranch         | 1                          | NV           | Washoe-Pershing | 40.86      | 119.32      | C                             | Y                             |

| <i>PROJID</i> | <i>Name:<br/>Field/District</i>   | <i>Name:<br/>Area/Power Plant</i> | <i>KGRA</i>            | <i>Area</i> <sup>(1)</sup> | <i>State</i> | <i>County</i>    | <i>Lat</i> | <i>Long</i> | <i>Expl-Dev.<br/>Cat. (2)</i> | <i>Gen.Cap.<br/>Estimated</i> |
|---------------|-----------------------------------|-----------------------------------|------------------------|----------------------------|--------------|------------------|------------|-------------|-------------------------------|-------------------------------|
| FLY01         | Fly Ranch/Granite Ranch           | Granite Ranch                     |                        | 1                          | NV           | Washoe-Pershing  | 40.86      | 119.32      | C                             | Y                             |
| GER00         | Gerlach                           | (Great Boiling Spring)            | Gerlach                | 1                          | NV           | Washoe           | 40.66      | 119.37      | C                             | Y                             |
| HAZ00         | Hazen (Black Butte)               | (Patua Hot Springs)               | Brady-Hazen (S end of) | 1                          | NV           | Lyon             | 39.6       | 119.11      | C                             | Y                             |
| HON00         | Honey Lake                        | Area-wide Summary                 | Wendel-Amedee          | 1                          | CA           | Lassen           | 40.33      | 120.20      | A                             | Y                             |
| HON01         | Honey Lake                        | Amedee                            | Wendel-Amedee          | 1                          | CA           | Lassen           | 40.30      | 120.20      | A                             | N                             |
| HON02         | Honey Lake                        | Wendel/Wineagle                   | Wendel-Amedee          | 1                          | CA           | Lassen           | 40.35      | 120.25      | A                             | N                             |
| HON03         | Honey Lake                        | Wendel/Honey Lake Power           | Wendel-Amedee          | 1                          | CA           | Lassen           | 40.37      | 120.25      | A                             | N                             |
| KYL00         | Kyle Hot Springs (Granite Mtn.)   | (Buena Vista Valley)              |                        | 1                          | NV           | Pershing         | 40.41      | 117.89      | C                             | Y                             |
| LEA00         | Leach Hot Springs                 | Grass Valley                      | Leach Hot Springs      | 1                          | NV           | Pershing         | 40.60      | 117.65      | C                             | Y                             |
| LEE00         | Lee Hot Springs                   |                                   |                        | 1                          | NV           | Churchill        | 39.21      | 118.72      | C                             | Y                             |
| LOC00         | Lockwood                          |                                   |                        | 1                          | NV           | Washoe           | 39.51      | 119.65      |                               | N                             |
| MCF00         | McFarlanes Hot Spring             | (Black Rock Desert)               |                        | 1                          | NV           | Humboldt         | 41.08      | 118.69      | D                             | N                             |
| NEW00         | New York Canyon                   |                                   |                        | 1                          | NV           | Pershing         | 40.05      | 118.00      | C                             | Y                             |
| NOR00         | North Valley                      |                                   |                        | 1                          | NV           | Churchill-Washoe | 39.90      | 119.22      | C                             | Y                             |
| PUM00         | Pumpnickel Valley                 | Tipton Ranch/Hot Springs Ranch    |                        | 1                          | NV           | Humboldt         | 40.76      | 117.49      | C                             | Y                             |
| PYR00         | Pyramid Lake Indian Reserv.       | (Needle Rocks Hot Springs)        |                        | 1                          | NV           | Washoe           | 40.15      | 119.68      | C                             | Y                             |
| ROS00         | Rose Creek                        |                                   |                        | 1                          | NV           | Pershing(?)      | 40.84      | 117.95      | D                             | N                             |
| RYE00         | Rye Patch-Humboldt House District | Field-wide summary                | Rye Patch              | 1                          | NV           | Pershing         | 40.53      | 118.27      | B                             | N                             |
| RYE01         | Rye Patch-Humboldt House District | Rye Patch                         | Rye Patch              | 1                          | NV           | Pershing         | 40.53      | 118.27      | B                             | Y                             |
| RYE02         | Rye Patch-Humboldt House District | Humboldt House                    | Rye Patch              | 1                          | NV           | Pershing         | 40.53      | 118.27      | C                             | Y                             |
| SAW00         | Salt Wells                        | Eight Mile Flat                   |                        | 1                          | NV           | Churchill        | 39.31      | 118.57      | C                             | Y                             |
| SOD00         | Soda Lake                         | Soda Lake No.1/No.2               | Stillwater-Soda Lake   | 1                          | NV           | Churchill        | 39.55      | 118.87      | A                             | Y                             |
| SOU00         | Southern Pacific                  |                                   |                        | 1                          | NV           | Churchill(?)     | 40.06      | 118.89      | D                             | N                             |

| <i>PROJID</i>                                       | <i>Name:<br/>Field/District</i> | <i>Name:<br/>Area/Power Plant</i>     | <i>KGRA</i>          | <i>Area</i> <sup>(1)</sup> | <i>State</i> | <i>County</i>                | <i>Lat</i> | <i>Long</i> | <i>Expl-Dev.<br/>Cat. (2)</i> | <i>Gen.Cap.<br/>Estimated</i> |
|---|---------------------------------|---------------------------------------|----------------------|----------------------------|--------------|------------------------------|------------|-------------|-------------------------------|-------------------------------|
| STE00   | Steamboat Hot Sprs              | Field-wide Summary                    | Steamboat Springs    | 1                          | NV           | Washoe                       | 39.38      | 117.76      | A                             | Y                             |
| STE01   | Steamboat Hot Sprs              | Lower SB: Steamboat I-1A              | Steamboat Springs    | 1                          | NV           | Washoe                       | 39.38      | 117.76      | A                             | N                             |
| STE02   | Steamboat Hot Sprs              | Lower SB: Steamboat II-III            | Steamboat Springs    | 1                          | NV           | Washoe                       | 39.38      | 117.76      | A                             | N                             |
| STE03   | Steamboat Hot Sprs              | Lower SB: Steamboat IV                | Steamboat Springs    | 1                          | NV           | Washoe                       | 39.38      | 117.76      | B                             | N                             |
| STE04   | Steamboat Hot Sprs              | Lower SB: UNV Redfield<br>Utility     | Steamboat Springs    | 1                          | NV           | Washoe                       | 39.38      | 117.76      | D                             | N                             |
| STE05   | Steamboat Hot Sprs              | Upper SB: Yankee-Caithness            | Steamboat Springs    | 1                          | NV           | Washoe                       | 39.38      | 117.76      | A                             | N                             |
| STI00   | Stillwater                      | Stillwater Geothermal 1               | Stillwater-Soda Lake | 1                          | NV           | Churchill                    | 39.55      | 118.55      | A                             | Y                             |
| STI01   | Stillwater                      | Stillwater N Expansion                | Stillwater-Soda Lake | 1                          | NV           | Churchill                    | 39.55      | 118.55      | B                             | Y                             |
| TRA00   | Tracy                           |                                       |                      | 1                          | NV           | Washoe                       | 39.57      | 119.53      | D                             | N                             |
| TRI00   | Trinity Mountains District      | Telephone Well area                   |                      | 1                          | NV           | Church.-<br>Persh.-<br>Wash. | 40.00      | 118.99      | D                             | Y                             |
| VIR00   | Virginia Range                  |                                       |                      | 1                          | NV           | Washoe                       | 39.42      | 119.66      |                               | N                             |
| WAB00   | Wabuska                         |                                       |                      | 1                          | NV           | Lyon                         | 39.16      | 118.18      | A                             | Y                             |
| <b><i>Area: 2 - NV with direct access to CA</i></b> |                                 |                                       |                      |                            |              |                              |            |             |                               |                               |
| AUR00   | Aurora                          |                                       |                      | 2                          | NV           | Mineral                      | 38.35      | 118.82      | C                             | Y                             |
| DIX00   | Dixie Valley                    | Caithness Dixie Valley                | Dixie Valley         | 2                          | NV           | Churchill                    | 39.99      | 117.85      | A                             | Y                             |
| DIX01   | Dixie Valley                    | Dixie Valley Power Partners<br>(DVPP) |                      | 2                          | NV           | Churchill                    | 39.99      | 117.85      | C                             | Y                             |
| ELE00   | Eleven Mile Canyon              |                                       |                      | 2                          | NV           | Churchill                    | 39.42      | 118.24      |                               | N                             |
| EMI00   | Emigrant (Fish Lake V.)         |                                       |                      | 2                          | NV           | Esmeralda                    | 37.86      | 117.87      | C                             | Y                             |
| EXC00   | Excelsior                       |                                       |                      | 2                          | NV           | Mineral                      | 38.31      | 118.56      |                               | N                             |
| FIS00   | Fish Lake (Valley)              |                                       |                      | 2                          | NV           | Esmeralda                    | 37.86      | 118.05      | B                             | Y                             |
| HAW00   | Hawthorne                       |                                       |                      | 2                          | NV           | Mineral                      | 38.53      | 118.65      | C                             | Y                             |
| HYD00   | Hyder Hot Springs               |                                       | Dixie Valley         | 2                          | NV           | Pershing                     | 39.99      | 117.71      | D                             | Y                             |
| PIR00   | Pirouette Mountain              | (S.Dixie Valley)                      |                      | 2                          | NV           | Churchill                    | 39.51      | 118.16      | D                             | Y                             |
| SIL00   | Silver Peak                     | (Alum prospect)                       |                      | 2                          | NV           | Esmeralda                    | 37.91      | 117.67      | C                             | Y                             |

| <i>PROJID</i>                 | <i>Name:<br/>Field/District</i> | <i>Name:<br/>Area/Power Plant</i> | <i>KGRA</i>          | <i>Area</i> <sup>(1)</sup> | <i>State</i> | <i>County</i> | <i>Lat</i> | <i>Long</i> | <i>Expl-Dev.<br/>Cat. (2)</i> | <i>Gen.Cap.<br/>Estimated</i> |
|-------------------------------|---------------------------------|-----------------------------------|----------------------|----------------------------|--------------|---------------|------------|-------------|-------------------------------|-------------------------------|
| SOH00                         | Sou Hot Springs                 | (Seven Devils/Gilbert's H.S.)     | Dixie Valley         | 2                          | NV           | Pershing      | 40.08      | 117.72      | D                             | Y                             |
| <b>Area: 3 - Other NV</b>     |                                 |                                   |                      |                            |              |               |            |             |                               |                               |
| ANT00                         | Antelope Valley                 |                                   |                      | 3                          | NV           | Churchill     | 39.83      | 117.50      | D                             | N                             |
| BAL00                         | Baltazor                        |                                   | Baltazor             | 3                          | NV           | Humboldt      | 41.92      | 118.72      | C                             | Y                             |
| BIG00                         | Big Smokey Valley               | N.End - Spencer Hot Springs       |                      | 3                          | NV           | Lander        | 39.33      | 116.83      | D                             | N                             |
| DAR00                         | Darrough Hot Springs            | (Big Smokey Valley - S.End)       | Darrough Hot Springs | 3                          | NV           | Nye           | 38.82      | 117.18      | C                             | N                             |
| DOU00                         | Double - Black Rk Hot Springs   |                                   | Double Hot Springs   | 3                          | NV           | Humboldt      | 41.05      | 119.03      | D                             | Y                             |
| DYK00                         | Dyke Hot Springs                |                                   |                      | 3                          | NV           | Humboldt      | 41.57      | 118.57      | D                             | N                             |
| FOX00                         | Fox Mountain                    |                                   |                      | 3                          | NV           | Washoe        | 41.02      | 119.56      | C                             | N                             |
| GRA00                         | Grass Valley                    | (Little Hot Springs)              |                      | 3                          | NV           | Lander        | 39.89      | 116.65      |                               | N                             |
| HSS00                         | Hot Sulphur Springs             | (Independence V./Tuscarora)       |                      | 3                          | NV           | Elko          | 41.47      | 116.15      | C                             | N                             |
| MCG00                         | McGee Mountain                  | (Painted Hills)                   |                      | 3                          | NV           | Humboldt      | 41.80      | 118.87      | C                             | Y                             |
| PIN00                         | Pinto Hot Springs               |                                   | Pinto Hot Springs    | 3                          | NV           | Humboldt      | 41.36      | 118.80      | D                             | Y                             |
| SHO00                         | Shoshone-Reese River            |                                   |                      | 3                          | NV           | Lander        | 39.89      | 117.14      | D                             | Y                             |
| WIL00                         | Wilson Hot Springs              |                                   | Wilson Hot Springs   | 3                          | NV           | Lyon          | 38.77      | 119.18      | D                             | Y                             |
| <b>Area: 4 - All other CA</b> |                                 |                                   |                      |                            |              |               |            |             |                               |                               |
| BOD00                         | Bodie                           |                                   | Bodie                | 4                          | CA           | Mono          | 38.16      | 119.11      | D                             | N                             |
| BRW00                         | Brawley                         | Area-wide summary                 | Brawley              | 4                          | CA           | Imperial      | 32.99      | 115.52      | B                             | N                             |
| BRW01                         | Brawley                         | Brawley (North Brawley)           | Brawley              | 4                          | CA           | Imperial      | 33.00      | 115.53      | B                             | Y                             |
| BRW02                         | Brawley                         | East Brawley                      |                      | 4                          | CA           | Imperial      | 32.99      | 115.35      | B                             | Y                             |
| BRW03                         | Brawley                         | South Brawley (Mesquite field)    |                      | 4                          | CA           | Imperial      | 32.96      | 115.54      | B                             | Y                             |
| CAL00                         | Calistoga                       |                                   | Geysers-Calistoga    | 4                          | CA           | Napa          | 38.58      | 122.58      | C                             | Y                             |
| COS00                         | Coso                            | Field-wide Summary                | Coso Hot Springs     | 4                          | CA           | Inyo          | 36.03      | 117.80      | A                             | Y                             |
| COS01                         | Coso                            | Navy I                            | Coso Hot Springs     | 4                          | CA           | Inyo          | 36.03      | 117.80      | A                             | N                             |
| COS02                         | Coso                            | Navy II                           | Coso Hot Springs     | 4                          | CA           | Inyo          | 36.03      | 117.80      | A                             | N                             |

| <i>PROJID</i> | <i>Name:<br/>Field/District</i> | <i>Name:<br/>Area/Power Plant</i> | <i>KGRA</i>       | <i>Area</i> <sup>(1)</sup> | <i>State</i> | <i>County</i>   | <i>Lat</i> | <i>Long</i> | <i>Expl-Dev.<br/>Cat. (2)</i> | <i>Gen.Cap.<br/>Estimated</i> |
|---------------|---------------------------------|-----------------------------------|-------------------|----------------------------|--------------|-----------------|------------|-------------|-------------------------------|-------------------------------|
| COS03         | Coso                            | BLM                               | Coso Hot Springs  | 4                          | CA           | Inyo            | 36.03      | 117.80      | A                             | N                             |
| COS04         | Coso                            | Northeast frontier                | Coso Hot Springs  | 4                          | CA           | Inyo            | 36.03      | 117.80      | D                             | N                             |
| DUN00         | Dunes                           |                                   | Dunes             | 4                          | CA           | Imperial        | 32.80      | 115.01      | C                             | Y                             |
| EAS00         | East Mesa                       | Field-wide summary                | East Mesa         | 4                          | CA           | Imperial        | 32.78      | 115.25      | A                             | Y                             |
| EAS01         | East Mesa                       | Ormesa 1                          | East Mesa         | 4                          | CA           | Imperial        | 32.78      | 115.25      | A                             | N                             |
| EAS02         | East Mesa                       | Ormesa 1E                         | East Mesa         | 4                          | CA           | Imperial        | 32.78      | 115.25      | A                             | N                             |
| EAS03         | East Mesa                       | Ormesa 1H                         |                   | 4                          | CA           | Imperial        | 32.78      | 115.25      | A                             | N                             |
| EAS04         | East Mesa                       | Ormesa 2 (or II)                  | East Mesa         | 4                          | CA           | Imperial        | 32.78      | 115.25      | A                             | N                             |
| EAS05         | East Mesa                       | Geo East Mesa (GEM) I             | East Mesa         | 4                          | CA           | Imperial        | 32.78      | 115.25      | A                             | N                             |
| EAS06         | East Mesa                       | Geo East Mesa (GEM) 2-3           | East Mesa         | 4                          | CA           | Imperial        | 32.78      | 115.25      | A                             | N                             |
| GEY00         | Geysers                         | Field-wide Summary                | Geysers/Calistoga | 4                          | CA           | Lake-Sonoma     | 38.8       | 122.75      | A                             | Y                             |
| GEY01         | Geysers                         | McCabe (Units 5 & 6)              | Geysers-Calistoga | 4                          | CA           | Sonoma          |            |             | A                             | N                             |
| GEY02         | Geysers                         | Ridgeline (Units 7 & 8)           | Geysers-Calistoga | 4                          | CA           | Sonoma          |            |             | A                             | N                             |
| GEY03         | Geysers                         | Fumarole (Units 9 & 10)           | Geysers-Calistoga | 4                          | CA           | Sonoma          |            |             | A                             | N                             |
| GEY04         | Geysers                         | Eagle Rock (Unit 11)              | Geysers-Calistoga | 4                          | CA           | Sonoma and Lake |            |             | A                             | N                             |
| GEY05         | Geysers                         | Cobb Creek (Unit 12)              | Geysers-Calistoga | 4                          | CA           | Sonoma          |            |             | A                             | N                             |
| GEY06         | Geysers                         | Big Geysers (Unit 13)             | Geysers-Calistoga | 4                          | CA           | Sonoma and Lake |            |             | A                             | N                             |
| GEY07         | Geysers                         | Sulphur Springs (Unit 14)         | Geysers-Calistoga | 4                          | CA           | Sonoma          |            |             | A                             | N                             |
| GEY08         | Geysers                         | Lake View (Unit 17)               | Geysers-Calistoga | 4                          | CA           | Sonoma and Lake |            |             | A                             | N                             |
| GEY09         | Geysers                         | NCPA 1 & 2                        | Geysers-Calistoga | 4                          | CA           | Sonoma and Lake |            |             | A                             | N                             |
| GEY10         | Geysers                         | Socrates (Unit 18)                | Geysers-Calistoga | 4                          | CA           | Sonoma and Lake |            |             | A                             | N                             |
| GEY11         | Geysers                         | Sonoma (SMUDGE0)                  | Geysers-Calistoga | 4                          | CA           | Sonoma and Lake |            |             | A                             | N                             |

| <i>PROJID</i> | <i>Name:<br/>Field/District</i> | <i>Name:<br/>Area/Power Plant</i>    | <i>KGRA</i>               | <i>Area</i> <sup>(1)</sup> | <i>State</i> | <i>County</i>      | <i>Lat</i> | <i>Long</i> | <i>Expl-Dev.<br/>Cat. (2)</i> | <i>Gen.Cap.<br/>Estimated</i> |
|---------------|---------------------------------|--------------------------------------|---------------------------|----------------------------|--------------|--------------------|------------|-------------|-------------------------------|-------------------------------|
| GEY12         | Geysers                         | Calistoga                            | Geysers-Calistoga         | 4                          | CA           | Sonoma<br>and Lake |            |             | A                             | N                             |
| GEY13         | Geysers                         | Quicksilver (Unit 16)                | Geysers-Calistoga         | 4                          | CA           | Lake               |            |             | A                             | N                             |
| GEY14         | Geysers                         | Grant (Unit 20)                      | Geysers-Calistoga         | 4                          | CA           | Sonoma             |            |             | A                             | N                             |
| GEY15         | Geysers                         | NCPA 3 & 4                           | Geysers-Calistoga         | 4                          | CA           | Sonoma<br>and Lake |            |             | A                             | N                             |
| GEY16         | Geysers                         | Bear Canyon                          | Geysers-Calistoga         | 4                          | CA           | Lake               |            |             | A                             | N                             |
| GEY17         | Geysers                         | West Ford Flat                       | Geysers-Calistoga         | 4                          | CA           | Lake               |            |             | A                             | N                             |
| GEY18         | Geysers                         | Aidlin                               | Geysers-Calistoga         | 4                          | CA           | Sonoma             |            |             | A                             | N                             |
| GEY19         | Geysers                         | Unit 15                              | Geysers-Calistoga         | 4                          |              | Sonoma             |            |             | B                             | N                             |
| GLA00         | Glamis                          |                                      | Glamis                    | 4                          | CA           | Imperial           | 32.97      | 115.04      | D                             | Y                             |
| HEB00         | Heber                           | Field-wide Summary                   | Heber                     | 4                          | CA           | Imperial           | 32.72      | 115.53      | A                             | Y                             |
| HEB01         | Heber                           | Heber (HGC)                          | Heber                     | 4                          | CA           | Imperial           | 32.72      | 115.53      | A                             | N                             |
| HEB02         | Heber                           | Second Imperial Geoth.<br>(SIGC)     | Heber                     | 4                          | CA           | Imperial           | 32.72      | 115.53      | A                             | N                             |
| LAK00         | Lake City / Surprise Valley     | Lake City                            | Lake City-Surprise Valley | 4                          | CA           | Modoc              | 41.67      | 120.22      | B                             | Y                             |
| LVC00         | Long Valley - Casa Diablo       | MP Field Summary                     | Mono-Long Valley          | 4                          | CA           | Mono               | 37.65      | 118.90      | A                             | N                             |
| LVC01         | Long Valley - Casa Diablo       | Mammoth-Pacific G1(MP-1)             | Mono-Long Valley          | 4                          | CA           | Mono               | 37.65      | 118.90      | A                             | N                             |
| LVC02         | Long Valley - Casa Diablo       | Mammoth-Pacific G2(MP-2)             | Mono-Long Valley          | 4                          | CA           | Mono               | 37.65      | 118.90      | A                             | N                             |
| LVC03         | Long Valley - Casa Diablo       | Mammoth-Pacific G3(PLES-<br>1)       | Mono-Long Valley          | 4                          | CA           | Mono               | 37.65      | 118.90      | A                             | N                             |
| LVM00         | Long Valley - M-P Leases        | M-P Lease Summary                    | Mono-Long Valley          | 4                          | CA           | Mono               | 37.65      | 118.90      | A                             | Y                             |
| LVM01         | Long Valley - M-P Leases        | Basalt Canyon Expl. Project          | Mono-Long Valley          | 4                          | CA           | Mono               | 37.65      | 118.90      | C                             | N                             |
| LVM02         | Long Valley - M-P Leases        | Upper Basalt Canyon Expl.<br>Project | Mono-Long Valley          | 4                          | CA           | Mono               | 37.65      | 118.90      | C                             | N                             |
| LVM03         | Long Valley - M-P Leases        | Rhyolite Plateau Exploration<br>Area | Mono-Long Valley          | 4                          | CA           | Mono               | 37.65      | 118.90      | C                             | N                             |
| MED00         | Medicine Lake                   | Field-wide Summary                   | Glass Mountain            | 4                          | CA           | Siskiyou           | 41.58      | 121.6       | B                             | N                             |
| MED01         | Medicine Lake                   | Fourmile Hill                        | Glass Mountain            | 4                          | CA           | Siskiyou           | 41.63      | 121.63      | B                             | Y                             |

| <i>PROJID</i> | <i>Name:<br/>Field/District</i> | <i>Name:<br/>Area/Power Plant</i> | <i>KGRA</i>              | <i>Area</i> <sup>(1)</sup> | <i>State</i> | <i>County</i>  | <i>Lat</i> | <i>Long</i> | <i>Expl-Dev.<br/>Cat. (2)</i> | <i>Gen.Cap.<br/>Estimated</i> |
|---------------|---------------------------------|-----------------------------------|--------------------------|----------------------------|--------------|----------------|------------|-------------|-------------------------------|-------------------------------|
| MED02         | Medicine Lake                   | Telephone Flat                    | Glass Mountain           | 4                          | CA           | Siskiyou       | 41.57      | 121.57      | B                             | Y                             |
| MED03         | Medicine Lake                   | Pumice Mine Prospect              | Glass Mountain           | 4                          | CA           | Siskiyou       |            |             | D                             | N                             |
| MOS00         | Mount Signal                    |                                   |                          | 4                          | CA           | Imperial       | 32.65      | 115.71      | C                             | Y                             |
| NIL00         | Niland                          |                                   |                          | 4                          | CA           | Imperial       | 33.22      | 115.54      | B                             | Y                             |
| RAN00         | Randsburg                       |                                   | Randsburg                | 4                          | CA           | San Bernardino | 35.38      | 117.53      | C                             | Y                             |
| SAI00         | Saline Valley                   |                                   | Saline Valley            | 4                          | CA           | Inyo           | 36.79      | 117.76      | D                             | N                             |
| SAL00         | Salton Sea                      | Field-wide summary                | Salton Sea               | 4                          | CA           | Imperial       | 33.17      | 115.62      | A                             | Y                             |
| SAL01         | Salton Sea                      | Unit 1                            | Salton Sea               | 4                          | CA           | Imperial       | 33.17      | 115.62      | A                             | N                             |
| SAL02         | Salton Sea                      | Unit 2                            | Salton Sea               | 4                          | CA           | Imperial       | 33.17      | 115.62      | A                             | N                             |
| SAL03         | Salton Sea                      | Unit 3                            | Salton Sea               | 4                          | CA           | Imperial       | 33.17      | 115.62      | A                             | N                             |
| SAL04         | Salton Sea                      | Unit 4                            | Salton Sea               | 4                          | CA           | Imperial       | 33.17      | 115.62      | A                             | N                             |
| SAL05         | Salton Sea                      | Unit 5                            | Salton Sea               | 4                          | CA           | Imperial       | 33.17      | 115.62      | A                             | N                             |
| SAL06         | Salton Sea                      | Unit 6                            | Salton Sea               | 4                          | CA           | Imperial       | 33.17      | 115.62      | B                             | N                             |
| SAL07         | Salton Sea                      | Vulcan                            | Salton Sea               | 4                          | CA           | Imperial       | 33.17      | 115.62      | A                             | N                             |
| SAL08         | Salton Sea                      | Del Ranch (Hoch)                  | Salton Sea               | 4                          | CA           | Imperial       | 33.17      | 115.62      | A                             | N                             |
| SAL09         | Salton Sea                      | Elmore                            | Salton Sea               | 4                          | CA           | Imperial       | 33.17      | 115.62      | A                             | N                             |
| SAL10         | Salton Sea                      | Leathers                          | Salton Sea               | 4                          | CA           | Imperial       | 33.17      | 115.62      | A                             | N                             |
| SAL11         | Salton Sea                      | Vulcan/Hoch Turboexpander         | Salton Sea               | 4                          | CA           | Imperial       | 33.17      | 115.62      | A                             | N                             |
| SES00         | Sespe Hot Springs               |                                   | Sespe Hot Springs        | 4                          | CA           | Ventura        | 34.60      | 119.00      | D                             | Y                             |
| SUL00         | Sulphur Bank                    | Clear Lake                        | Geysers/Calistoga        | 4                          | CA           | Lake           | 39.00      | 122.66      | B                             | Y                             |
| SUP00         | Superstition Mountain           |                                   |                          | 4                          | CA           | Imperial       | 32.95      | 115.80      | D                             | Y                             |
| TRU00         | Truckhaven                      |                                   |                          | 4                          | CA           | Imperial       | 33.26      | 116.00      | C                             | N                             |
| TRU01         | Truckhaven                      |                                   |                          | 4                          | CA           | Imperial       | 33.26      | 116.00      | C                             | N                             |
| WES00         | Westmorland                     |                                   | Westmorland - Salton Sea | 4                          | CA           | Imperial       | 33.08      | 115.65      | C                             | N                             |

| <i>PROJID</i> | <i>Name:<br/>Field/District</i> | <i>Name:<br/>Area/Power Plant</i> | <i>KGRA</i> | <i>Area</i> <sup>(1)</sup> | <i>State</i> | <i>County</i> | <i>Lat</i> | <i>Long</i> | <i>Expl-Dev.<br/>Cat. (2)</i> | <i>Gen.Cap.<br/>Estimated</i> |
|---------------|---------------------------------|-----------------------------------|-------------|----------------------------|--------------|---------------|------------|-------------|-------------------------------|-------------------------------|
|---------------|---------------------------------|-----------------------------------|-------------|----------------------------|--------------|---------------|------------|-------------|-------------------------------|-------------------------------|

**(1) Geographic Areas:**

Area 1 – Greater Reno, Nevada (includes California locations)

Area 2 – Nevada sites with direct access to the California grid, excluding Greater Reno

Area 3 – Other Nevada locations

Area 4 – All other California

**(2) Exploration-Development Categories:**

A – Existing power plant operating

B – One or more wells tested at  $\geq 1$  MW (no power plant in operation)

C – Minimum 212°F logged downhole (no well tests at  $\geq 1$  MW)

D – Other exploration data and information available ( $\geq 212^\circ\text{F}$  not proven)

No category assigned – area does not meet the minimum criteria (see Final Report section 2.2)

**Hetch Hetchy/SFPUC Programmatic Renewable Energy Project**  
**Project: 1.3 New Geothermal Site Identification and Qualification**  
**Project Team: GeothermEx, Inc.**  
**Task: 1.3.10 Final Project Report**  
**Subject: D.1.3.10.3 Final Report**

***Table 3: Estimated Generation Capacities***

| PROJ<br>ID                         | Field or District               | Area or<br>Power Plant         | State | County          | Temperature (°F) <sup>1</sup> |      |      | Volume <sup>2</sup><br>(mi <sup>3</sup> ) | Installed Capacity (MW) <sup>3</sup> |     |     | Wellhd.<br>MW in<br>use <sup>4</sup> | Explor-<br>Devel.<br>Cat. <sup>5</sup> | Generation Capacity (MW-30yrs) <sup>6</sup> |     |      |           |
|------------------------------------|---------------------------------|--------------------------------|-------|-----------------|-------------------------------|------|------|---|--------------------------------------|-----|-----|--------------------------------------|--|---|-----|------|-----------|
|                                    |                                 |                                |       |                 | Min                           | Mlk  | Max  |   | Gross                                | -   | Net |                                      |  | Min   | Mlk | Mean | Std. Dev. |
| Area: 1 - Greater Reno (NV and CA) |                                 |                                |       |                 |                               |      |      |   |                                      |     |     |                                      |  |   |     |      |           |
| BEO00                              | Beowawe                         |                                | NV    | Eureka-Lander   | 400°                          | 410° | 420° | 1.70                                      | 16.7                                 | 16  | 15  | A                                    | 30                                     | 41  | 58  | 21   |           |
| BLU00                              | Blue Mountain                   |                                | NV    | Humboldt        | 291°                          | 345° | 440° | 1.33                                      | 0                                    | -   | 0   | C                                    | 16                                     | 30  | 38  | 19   |           |
| BRA00                              | Brady's Hot Springs             |                                | NV    | Churchill       | 340°                          | 360° | 380° | 0.76                                      | 26                                   | 20  | 15  | A                                    | 11                                     | 18  | 22  | 8.3  |           |
| COL00                              | Colado                          |                                | NV    | Pershing        | 215°                          | 270° | 330° | 0.80                                      | 0                                    | -   | 0   | C                                    | 3.7                                    | 6.2   | 8.3 | 4.1  |           |
| DES00                              | Desert Peak                     |                                | NV    | Churchill       | 370°                          | 385° | 400° | 2.27                                      | 11                                   | 9.9 | 10  | A                                    | 33                                     | 45  | 79  | 40   |           |
| EMP00                              | Empire (San Emidio)             | Field-wide summary             | NV    | Washoe          | 285°                          | 305° | 330° | 0.62                                      | 4.8                                  | 4.6 | 4.8 | A                                    | 4.3                                    | 6.6   | 11  | 6.7  |           |
| FAL00                              | Fallon / Carson Lake            | Carson Lake anomaly            | NV    | Churchill       | 360°                          | 370° | 380° | 2.61                                      | 0                                    | -   | 0   | C                                    | 34                                     | 55  | 74  | 34   |           |
| FLY00                              | Fly Ranch/Granite Ranch         | Ward's (Fly/Hualapi Flat) H.S. | NV    | Washoe-Pershing | 200°                          | 220° | 210° | 2.40                                      | 0                                    | -   | 0   | C                                    | 6.0                                    | 8.7   | 13  | 5.7  |           |
| FLY01                              | Fly Ranch/Granite Ranch         | Granite Ranch                  | NV    | Washoe-Pershing | 221°                          | 345° | 440° | 0.53                                      | 0                                    | -   | 0   | C                                    | 5.4                                    | 8.1   | 13  | 7.1  |           |
| GER00                              | Gerlach                         | (Great Boiling Spring)         | NV    | Washoe          | 290°                          | 340° | 385° | 2.50                                      | 0                                    | -   | 0   | C                                    | 17                                     | 25  | 36  | 16   |           |
| HAZ00                              | Hazen (Black Butte)             | (Patua Hot Springs)            | NV    | Lyon            | 280°                          | 330° | 430° | 1.25                                      | 0                                    | -   | 0   | C                                    | 6.3                                    | 8.5   | 14  | 6.9  |           |
| HON00                              | Honey Lake                      | Area-wide Summary              | CA    | Lassen          | 230°                          | 240° | 250° | 1.09                                      | 6.4                                  | 3.4 | 1.2 | A                                    | 5.7                                    | 8.3   | 13  | 6.9  |           |
| KYL00                              | Kyle Hot Springs (Granite Mtn.) | (Buena Vista Valley)           | NV    | Pershing        | 280°                          | 375° | 412° | 0.99                                      | 0                                    | -   | 0   | C                                    | 16                                     | 22  | 36  | 19   |           |
| LEA00                              | Leach Hot Springs               | Grass Valley                   | NV    | Pershing        | 220°                          | 265° | 343° | 1.79                                      | 0                                    | -   | 0   | C                                    | 13                                     | 18  | 29  | 15   |           |

| PROJ<br>ID              | Field or District                    | Area or<br>Power Plant            | State | County                      | <u>Temperature (°F)</u> <sup>1</sup> |      |      | <u>Volume</u> <sup>2</sup> |       | <u>Installed Capacity (MW)</u> <sup>3</sup> |      | <u>Wellhd.<br/>MW in<br/>use</u> <sup>4</sup> | <u>Explor-<br/>Devel.<br/>Cat.</u> <sup>5</sup> | <u>Generation Capacity (MW-30yrs)</u> <sup>6</sup> |     |      |                  |
|-------------------------|--------------------------------------|-----------------------------------|-------|-----------------------------|--------------------------------------|------|------|----------------------------|-------|---|------|---|---|--|-----|------|------------------|
|                         |                                      |                                   |       |                             | Min                                  | Mlk  | Max  | (mi <sup>3</sup> )         | Gross | -   | Net  |   |   | Min  | Mlk | Mean | Std. Dev.        |
| LEE00                   | Lee Hot Springs                      |                                   | NV    | Churchill                   | 303°                                 |      | 324° | 0.53                       | 0     | -   | 0    | C   |   | 5.4  | 9.4 | 11   | 5.1              |
| NEW00                   | New York Canyon                      |                                   | NV    | Pershing                    | 245°                                 | 345° | 440° | 1.72                       | 0     | -   | 0    | C   |   | 20   | 26  | 46   | 23               |
| NOR00                   | North Valley                         |                                   | NV    | Churchill-<br>Washoe        | 255°                                 | 345° | 440° | 3.18                       | 0     | -   | 0    | C   |   | 37   | 49  | 84   | 43               |
| PUM00                   | Pumpnickel Valley                    | Tipton Ranch/Hot<br>Springs Ranch | NV    | Humboldt                    | 235°                                 | 295° | 356° | 1.19                       | 0     | -   | 0    | C   |   | 10   | 13  | 22   | 11               |
| PYR00                   | Pyramid Lake Indian<br>Reserv.       | (Needle Rocks Hot<br>Springs)     | NV    | Washoe                      | 240°                                 | 345° | 417° | 0.93                       | 0     | -   | 0    | C   |   | 9.9  | 14  | 23   | 12               |
| RYE01                   | Rye Patch-Humboldt<br>House District | Rye Patch                         | NV    | Pershing                    | 335°                                 | 345° | 405° | 1.13                       | 12.5  | 8.75  | 0    | B   |   | 16   | 20  | 34   | 15               |
| RYE02                   | Rye Patch-Humboldt<br>House District | Humboldt House                    | NV    | Pershing                    | 290°                                 | 345° | 440° | 2.12                       | 0     | -   | 0    | C   |   | 27   | 34  | 60   | 30               |
| SAW00                   | Salt Wells                           | Eight Mile Flat                   | NV    | Churchill                   | 330°                                 | 400° | 430° | 3.98                       | 0     | -   | 0    | C   |   | 63   | 96  | 136  | 63               |
| SOD00                   | Soda Lake                            | Soda Lake No.1/No.2               | NV    | Churchill                   | 340°                                 | 360° | 370° | 2.12                       | 26.1  | 16.6  | 15.7 | A   |   | 29   | 42  | 62   | 28               |
| STE00                   | Steamboat Hot Sprs                   | Field-wide Summary                | NV    | Washoe                      | 350°                                 | 370° | 390° | 2.33                       | 59.84 | 48.1  | 53   | A   |   | 56   | 62  | 78   | 17               |
| STI00                   | Stillwater                           | Stillwater Geothermal 1           | NV    | Churchill                   | 290°                                 | 310° | 330° | 1.09                       | 19    | 10  | 14.3 | A   |   | 11   | 18  | 21   | 8.0              |
| STI01                   | Stillwater                           | Stillwater N Expansion            | NV    | Churchill                   | 310°                                 | 330° | 350° | 1.36                       | 0     | -   | 0    | B   |   | 16   | 24  | 31   | 11               |
| TRI00                   | Trinity Mountains District           | Telephone Well area               | NV    | Church.-<br>Pers.-<br>Wash. | 225°                                 | 345° | 440° | 3.98                       | 0     | -   | 0    | D   |   | 42   | 66  | 100  | 53               |
| WAB00                   | Wabuska                              |                                   | NV    | Lyon                        | 225°                                 | 245° | 290° | 1.33                       | 1.45  | 1.2   | 1.4  | A   |   | 8.1  | 13  | 17   | 8.0              |
| <b>Totals for Area:</b> |                                      |                                   |       |                             |                                      |      |      |                            | 184   | 139   | 130  |   |   | 552  | 787 | 1169 | 129 <sup>7</sup> |

**Area: 2 - NV with direct access to CA**

|       |              |                        |    |           |      |      |      |      |    |    |    |   |  |     |     |     |    |
|-------|--------------|------------------------|----|-----------|------|------|------|------|----|----|----|---|--|-----|-----|-----|----|
| AUR00 | Aurora       |                        | NV | Mineral   | 250° | 345° | 440° | 2.65 | 0  | -  | 0  | C |  | 31  | 51  | 70  | 35 |
| DIX00 | Dixie Valley | Caithness Dixie Valley | NV | Churchill | 420° | 440° | 460° | 3.17 | 66 | 56 | 66 | A |  | 71  | 107 | 142 | 56 |
| DIX01 | Dixie Valley | Dixie Valley Power     | NV | Churchill | 445° | 460° | 475° | 4.69 | 0  | -  | 0  | C |  | 107 | 151 | 210 | 83 |

| PROJ<br>ID             | Field or District             | Area or<br>Power Plant         | State | County    | Temperature (°F) <sup>1</sup> |      |      | Volume<br>(mi <sup>3</sup> ) <sup>2</sup> | Installed Capacity (MW) <sup>3</sup> |   |     | Wellhd.<br>MW in<br>use <sup>4</sup> | Explor-<br>Devel.<br>Cat. <sup>5</sup> | Generation Capacity (MW-30yrs) <sup>6</sup> |     |      |           |                  |
|------------------------|-------------------------------|--------------------------------|-------|-----------|-------------------------------|------|------|---|--------------------------------------|---|-----|--------------------------------------|--|---|-----|------|-----------|------------------|
|                        |                               |                                |       |           | Min                           | Mlk  | Max  |   | Gross                                | - | Net |                                      |  | Min   | Mlk | Mean | Std. Dev. |                  |
| Partners (DVPP)        |                               |                                |       |           |                               |      |      |   |                                      |   |     |                                      |  |   |     |      |           |                  |
| EMI00                  | Emigrant (Fish Lake V.)       |                                | NV    | Esmeralda | 230°                          | 340° | 450° | 6.77                                      | 0                                    | - | 0   | C                                    | 49                                     | 85  | 118 | 63   |           |                  |
| FIS00                  | Fish Lake (Valley)            |                                | NV    | Esmeralda | 340°                          |      | 380° | 2.25                                      | 0                                    | - | 0   | B                                    | 30                                     | 47  | 62  | 27   |           |                  |
| HAW00                  | Hawthorne                     |                                | NV    | Mineral   | 200°                          | 285° | 440° | 1.06                                      | 0                                    | - | 0   | C                                    | 8.7                                    | 14  | 22  | 13   |           |                  |
| HYD00                  | Hyder Hot Springs             |                                | NV    | Pershing  | 180°                          |      | 310° | 1.67                                      | 0                                    | - | 0   | D                                    | 5.5                                    | 9.6   | 15  | 8.4  |           |                  |
| PIR00                  | Pirouette Mountain            | (S.Dixie Valley)               | NV    | Churchill | 190°                          | 345° | 440° | 1.52                                      | 0                                    | - | 0   | D                                    | 16                                     | 23  | 40  | 22   |           |                  |
| SIL00                  | Silver Peak                   | (Alum prospect)                | NV    | Esmeralda | 310°                          | 345° | 440° | 2.85                                      | 0                                    | - | 0   | C                                    | 41                                     | 78  | 91  | 43   |           |                  |
| SOH00                  | Sou Hot Springs               | (Seven Devils/Gilbert's H.S.)  | NV    | Pershing  | 180°                          |      | 370° | 0.53                                      | 0                                    | - | 0   | D                                    | 3.3                                    | 6.1   | 9.5 | 6.1  |           |                  |
| Totals for Area:       |                               |                                |       |           |                               |      |      |   | 66                                   |   | 56  |                                      | 66                                     |   | 363 | 572  | 780       | 136 <sup>7</sup> |
| Area: 3 - Other NV     |                               |                                |       |           |                               |      |      |   |                                      |   |     |                                      |  |   |     |      |           |                  |
| BAL00                  | Baltazor                      |                                | NV    | Humboldt  | 288°                          | 306° | 316° | 1.19                                      | 0                                    | - | 0   | C                                    | 11                                     | 16  | 24  | 11   |           |                  |
| DOU00                  | Double - Black Rk Hot Springs |                                | NV    | Humboldt  | 240°                          | 255° | 275° | 2.12                                      | 0                                    | - | 0   | D                                    | 20                                     | 33  | 53  | 31   |           |                  |
| MCG00                  | McGee Mountain                | (Painted Hills)                | NV    | Humboldt  | 225°                          | 345° | 440° | 1.86                                      | 0                                    | - | 0   | C                                    | 19                                     | 28  | 47  | 26   |           |                  |
| PIN00                  | Pinto Hot Springs             |                                | NV    | Humboldt  | 285°                          | 366° | 440° | 1.33                                      | 0                                    | - | 0   | D                                    | 18                                     | 29  | 39  | 19   |           |                  |
| SHO00                  | Shoshone-Reese River          |                                | NV    | Lander    | 225°                          | 345° | 440° | 1.19                                      | 0                                    | - | 0   | D                                    | 13                                     | 18  | 30  | 16   |           |                  |
| WIL00                  | Wilson Hot Springs            |                                | NV    | Lyon      | 200°                          | 345° | 440° | 1.13                                      | 0                                    | - | 0   | D                                    | 10                                     | 17  | 27  | 15   |           |                  |
| Totals for Area:       |                               |                                |       |           |                               |      |      |   | 0                                    |   |     |                                      | 0                                      |   | 91  | 141  | 220       | 51 <sup>7</sup>  |
| Area: 4 - All other CA |                               |                                |       |           |                               |      |      |   |                                      |   |     |                                      |  |   |     |      |           |                  |
| BRW01                  | Brawley                       | Brawley (North Brawley)        | CA    | Imperial  | 490°                          | 510° | 530° | 2.45                                      | 0                                    | - | 0   | B                                    | 88                                     | 135   | 144 | 45   |           |                  |
| BRW02                  | Brawley                       | East Brawley                   | CA    | Imperial  | 480°                          | 520° | 560° | 2.21                                      | 0                                    | - | 0   | B                                    | 85                                     | 129   | 138 | 44   |           |                  |
| BRW03                  | Brawley                       | South Brawley (Mesquite field) | CA    | Imperial  | 480°                          | 500° | 520° | 1.19                                      | 0                                    | - | 0   | B                                    | 45                                     | 62  | 70  | 21   |           |                  |

| PROJ<br>ID              | Field or District           | Area or<br>Power Plant | State | County         | <u>Temperature (°F)</u> <sup>1</sup> |      |      | <u>Volume</u> <sup>2</sup><br>(mi <sup>3</sup> ) | <u>Installed Capacity (MW)</u> <sup>3</sup> |      |      | <u>Wellhd.</u><br>MW in<br>use <sup>4</sup> | <u>Explor-<br/>Devel.</u><br>Cat. <sup>5</sup> | <u>Generation Capacity (MW-30yrs)</u> <sup>6</sup> |      |      |                  |
|-------------------------|-----------------------------|------------------------|-------|----------------|--------------------------------------|------|------|--|---|------|------|---|--|--|------|------|------------------|
|                         |                             |                        |       |                | Min                                  | Mlk  | Max  |  | Gross                                       | -    | Net  |   |  | Min  | Mlk  | Mean | Std. Dev.        |
| CAL00                   | Calistoga                   |                        | CA    | Napa           | 275°                                 |      | 320° | 1.86   | 0   | -    | 0    | C   |  | 17   | 25   | 35   | 16               |
| COS00                   | Coso                        | Field-wide Summary     | CA    | Inyo           | 475°                                 | 550° | 575° | 8.52   | 300   | 270  | 280  | A   |  | 246  | 355  | 490  | 189              |
| DUN00                   | Dunes                       |                        | CA    | Imperial       | 250°                                 |      | 400° | 0.86   | 0   | -    | 0    | C   |  | 7.4  | 11   | 18   | 10               |
| EAS00                   | East Mesa                   | Field-wide summary     | CA    | Imperial       | 300°                                 | 310° | 320° | 8.54   | 73.2  | 56   | 62   | A   |  | 119  | 148  | 167  | 38               |
| GEY00                   | Geysers                     | Field-wide Summary     | CA    | Lake-Sonoma    | 464°                                 | 468° | 482° | 37.88  | 1000  | 900  | 850  | A   |  | 1200   | 1400 | 1400 | N1               |
| GLA00                   | Glamis                      |                        | CA    | Imperial       | 250°                                 |      | 400° | 0.83   | 0   | -    | 0    | D   |  | 4.3  | 6.4  | 11   | 6.0              |
| HEB00                   | Heber                       | Field-wide Summary     | CA    | Imperial       | 330°                                 | 340° | 360° | 6.73   | 100   | 79   | 100  | A   |  | 109  | 142  | 158  | 40               |
| LAK00                   | Lake City / Surprise Valley | Lake City              | CA    | Modoc          | 320°                                 | 335° | 350° | 2.18   | 0   | -    | 0    | B   |  | 23   | 37   | 49   | 21               |
| LVM00                   | Long Valley - M-P Leases    | M-P Lease Summary      | CA    | Mono           | 342°                                 | 362° | 382° | 8.18   | 40  | 30.1 | 40   | A   |  | 70   | 111  | 148  | 65               |
| MED01                   | Medicine Lake               | Fourmile Hill          | CA    | Siskiyou       | 388°                                 | 428° | 455° | 2.05   | 0   | -    | 0    | B   |  | 25   | 36   | 70   | 42               |
| MED02                   | Medicine Lake               | Telephone Flat         | CA    | Siskiyou       | 440°                                 | 480° | 490° | 5.05   | 0   | -    | 0    | B   |  | 110  | 175  | 256  | 128              |
| MOS00                   | Mount Signal                |                        | CA    | Imperial       | 250°                                 | 345° | 440° | 1.19   | 0   | -    | 0    | C   |  | 12   | 19   | 29   | 15               |
| NIL00                   | Niland                      |                        | CA    | Imperial       | 500°                                 | 540° | 550° | 1.39   | 0   | -    | 0    | B   |  | 59   | 76   | 92   | 27               |
| RAN00                   | Randsburg                   |                        | CA    | San Bernardino | 240°                                 | 345° | 440° | 3.31   | 0   | -    | 0    | C   |  | 32   | 48   | 82   | 46               |
| SAL00                   | Salton Sea                  | Field-wide summary     | CA    | Imperial       | 550°                                 | 575° | 600° | 25.71  | 350   | 326  | 350  | A   |  | 1350   | 1750 | 1880 | 400              |
| SES00                   | Sespe Hot Springs           |                        | CA    | Ventura        | 230°                                 | 265° | 300° | 0.53   | 0   | -    | 0    | D   |  | 3.6  | 5.3  | 7.8  | 3.6              |
| SUL00                   | Sulphur Bank                | Clear Lake             | CA    | Lake           | 400°                                 |      | 450° | 1.66   | 0   | -    | 0    | B   |  | 27   | 43   | 61   | 30               |
| SUP00                   | Superstition Mountain       |                        | CA    | Imperial       | 225°                                 | 345° | 440° | 0.66   | 0   | -    | 0    | D   |  | 5.9  | 9.5  | 15   | 8.0              |
| <b>Totals for Area:</b> |                             |                        |       |                |                                      |      |      |  | 1863  | 1661 | 1682 |   |  | 3638   | 4723 | 5321 | 480 <sup>7</sup> |

| PROJ<br>ID    | Field or District | Area or<br>Power Plant | State | County | <u>Temperature (°F)</u> <sup>1</sup> |     |     | <u>Volume</u> <sup>2</sup><br>(mi <sup>3</sup> ) | <u>Installed</u> <sup>3</sup><br><u>Capacity (MW)</u> |       | <u>Wellhd.</u><br><u>MW in</u><br><u>use</u> <sup>4</sup> | <u>Explor-<br/>Devel.</u><br><u>Cat.</u> <sup>5</sup> | <u>Generation Capacity (MW-30yrs)</u> <sup>6</sup> |      |      |                  |
|---------------|-------------------|------------------------|-------|--------|--------------------------------------|-----|-----|--|---|-------|---|---|--|------|------|------------------|
|               |                   |                        |       |        | Min                                  | Mlk | Max |  | Gross   | - Net |   |   | Min  | Mlk  | Mean | Std. Dev.        |
| Grand Totals: |                   |                        |       |        |                                      |     |     |  | 2113  | 1856  | 1878  |   | 4644   | 6223 | 7490 | 518 <sup>7</sup> |

1. Reservoir temperature values used for Monte-Carlo estimation of generation capacity.

Min = minimum average; Mlk = most-likely average; Max = Maximum average.

2. The listed reservoir volume is the product: (most-likely average reservoir thickness) x (most-likely reservoir area), where the most-likely values are those used for Monte-Carlo estimation of generation capacity.

3. Installed generation capacity, gross and net MW. Applies only to Exploration-Development Category A.

4. MW in use is based on the most recent record of actual generation. Gross generation is listed if available, but available information is often not specific about gross vs. net.

5. Exploration-Development Category

A = existing power plant operating

B = one or more wells tested at  $\geq 1$  MW

C = a temperature  $\geq 212^\circ\text{F}$  has been logged downhole (or boiling temperature for local elevation)

D = other exploration data (such as spring chemistry and/or shallow temperature gradient measurements)

6. Min = Minimum = generation capacity value with Monte Carlo simulation cumulative probability of more than 90%

Mlk = Most-likely = Monte Carlo simulation modal generation capacity value

Mean = Monte Carlo simulation mean value

Std.Dev. = Standard Deviation of the Mean value

7. The standard deviation of the sum of mean values is the square root of the sum of the squares of individual standard deviations.



**Hetch Hetchy/SFPUC Programmatic Renewable Energy Project**  
**Project: 1.3 New Geothermal Site Identification and Qualification**  
**Project Team: GeothermEx, Inc.**  
**Task: 1.3.10 Final Project Report**  
**Subject: D.1.3.10.3 Final Report**

***Table 4: Comments to Estimated Generation Capacities***

***PROJ ID Field or District Area or Power Plant Comments/Notes***

***Area: 1 - Greater Reno (NV and CA)***

|       |                     |   |
|-------|---------------------|---|
| BEO00 | Beowawe             | Figure BEO00-3. Based on relatively good and complete data. Estimate does not include heat reserves in the discharge (upflow) zone to the hot springs area (above a depth of about 6,500 ft), but the temperature model (Figure BEO00-2) suggests that the volume of this zone is quite small relative to deeper reserves. The histogram of estimated values has a broad maximum, which makes the most-likely value relatively non-unique.  |
| BLU00 | Blue Mountain       | Figure BLU00-5. Area of reservoir may be underestimated (insufficient data), causing under-estimation of capacity. The capacity estimate is optimistic if deeper temperatures do not prove higher than the confirmed 291°F, and deeper permeability is not found.   |
| BRA00 | Brady's Hot Springs | Figure BRA00-3. The histogram of estimated values has a broad maximum, which makes the most-likely value relatively non-unique. The major uncertain parameter is the reservoir volume, which is hard to estimate due to irregular shape. On the basis of available information, it would be difficult to justify a volume significantly (say, 2x) greater than that represented for the capacity estimate. There is evidence of a laterally extensive volume of hot rock ( $\geq 390$ -410°F) at depth below the commercial reservoir, mostly in the footwall (east side) of the Bradys fault, and mostly below the depths represented by this capacity estimate. Available evidence indicates that the permeability in this hot rock is localized to the area near the Bradys fault; deep wells drilled into this rock from locations further to the east have so far been dry holes. The more permeable part of this rock, near the Bradys fault, is considered to be included in the capacity estimate. Greater heat reserves would be calculated by including a larger volume of this deep hot rock, but boundary conditions (depth to bottom and area) would still have to be assumed. |
| COL00 | Colado              | Figure COL00-2. The capacity may be under-estimated. The estimate is constrained by apparent low temperature and a limitation of the reservoir area to the default values assumed for a point source. The reservoir area may be under-estimated. The temperature estimates used for calculating capacity are based on geothermometers applied to samples from warm wells (max. 155°F) in the area of Colado junction, which is assumed to be about 1.5 miles from the area of upwelling. Therefore, it is likely that even the highest geothermometers have re-equilibrated and may be under-estimating true conditions at depth. The Na-Cl composition of the water (Cl about 2,500 mg/l) encourages the possibility of a higher-temperature geothermal system at depth, but could instead be a function of flow through meta-sedimentary rocks at lower temperatures. Hot water samples from the assumed area of upwelling, just S of Woolsey, would be useful. Reservoir permeability could be limited if confined to fine-grained metasedimentary rocks.  |

***PROJ ID Field or District Area or Power Plant Comments/Notes***

|       |                         |                                |  |
|-------|-------------------------|--------------------------------|--|
| DES00 | Desert Peak             |                                | Figure DES00-4. The capacity estimate represents both the existing hydrothermal project area and the EGS (Enhanced Geothermal Systems) area of hot rock but apparent lesser permeability to the NNE (see Figures). Input parameters are relatively well-constrained by drilling and production data.   |
| EMP00 | Empire (San Emidio)     | Field-wide summary             | Figure EMP00-2. Most of the drilling at Empire has been confined to a narrow, N-S zone that coincides with hydrothermal alteration and hot springs, with significant (and unsuccessful) step-out drilling only to the W. Successful exploration to the E would produce results that increase the capacity estimate, by increasing the estimated minimum reservoir area. Depths of greater than 2,000 ft below the central zone have also not been explored.  |
| FAL00 | Fallon / Carson Lake    | Carson Lake anomaly            | Figure FAL00-6. One deep and productive well (a slim hole) has been drilled so-far, at the western edge of the anomaly. The top of the reservoir is at c.5,850 ft depth. Large anomaly is promising.   |
| FLY00 | Fly Ranch/Granite Ranch | Ward's (Fly/Hualapi Flat) H.S. | Figure FLY00-3. A chemical geothermometer estimate of 308°F has not been used for the capacity estimate, because drilling to 5,000 ft encountered a maximum of only 210°F. Thus, the capacity estimate represents a low-temperature system (200°-220°F) over an area of 1.2 to 3.4 square miles (indicated by temperature gradient holes, and very approximate). Deep drilling has not established commercial levels of permeability.  |
| FLY01 | Fly Ranch/Granite Ranch | Granite Ranch                  | Figure FLY01-1. Granite Ranch area, 5 miles to the S of Fly Ranch (See Figure FLY00-1). Shallow drilling has encountered 221°F at 130 ft, with a reversal below. No fluids samples. Estimate is based on default values for a point source, except for a minimum average 221°F.  |
| GER00 | Gerlach                 | (Great Boiling Spring)         | Figure GER00-1. A hole to 5,870 ft found c.200°F and was dry, but the chemical geothermometers of all three hot springs in the area have a good probability of being accurate at 290°-380°F. Results of drilling to c.3,000 ft in the early-mid 1990s are not available. The capacity estimate depends strongly on assumed reservoir thickness, and on areal extent based only on the hot spring distribution, with support from the distribution of temperatures at 30 m depth.   |
| HAZ00 | Hazen (Black Butte)     | (Patua Hot Springs)            | Figure HAZ00-1. This estimate uses the chemical geothermometers of the hot springs and default values for other input parameters. The area used is a point source, and depth is the Nevada default. It thus calculates the amount of heat present in a thickness that would require drilling to at least several thousand feet. Prior drilling has established that there is productivity of water at c.280°F from less than 800 ft., and a developer might seek to exploit this shallow source. In such a case, the estimated generation capacity would be several MW at most, but for a point source. It is reasonably likely that the system area is at least somewhat greater. |
| HON00 | Honey Lake              | Area-wide Summary              | Figure HON00-4. Assumes a relatively thin reservoir, which may not be correct, but drilling costs could prohibit exploiting deeper zones unless higher temperatures are discovered. A higher temperature source is suggested by a fluids mixing model for Wendel H.S. and Amedee H.S. Existing production of about 5 MW gr is very localized in three areas (projects HON01-03) that together cover only a small fraction of the total apparent area of the heat anomaly, and this does suggest that the thickness of the reservoir has been under-estimated.  |

***PROJ ID Field or District Area or Power Plant Comments/Notes***

|       |                                   |                                |  |
|-------|-----------------------------------|--------------------------------|--|
| KYL00 | Kyle Hot Springs (Granite Mtn)    |                                | (Buena Vista Valley) Figure KYL00-2. May be an under-estimate. The definite possibility that Kyle H.S. is a mixed water means that the Min average resource temperature may be higher than the 280°F value which has been used. Further chemical studies and results from near-by petroleum exploration wells (not presently in the public domain) need to be considered.  |
| LEA00 | Leach Hot Springs                 | Grass Valley                   | Figure LEA00-5. Fairly uncertain. The only deep well was dry (257°F at 8,565 ft.)  |
| LEE00 | Lee Hot Springs                   |                                | Figure LEE00-1. Dependent on default input parameter values except for chemical geothermometers of the hot spring water.   |
| NEW00 | New York Canyon                   |                                | Figure NEW00-2. Very uncertain. Area is not well-defined and could be larger. Other parameters are default values. The maximum measured temperature is 166°F at 1,180 ft but with a high BH gradient (c.9°F/100 ft). Steam has been reported from a separate 140 ft-deep hole. A kaolinite deposit indicates former hot spring activity and fairly high temperatures, at least in the past. This area is assigned to Exploration-Development Category C on the basis of reported shallow steam, not actual measured temperature.   |
| NOR00 | North Valley                      |                                | Figure NOR00-2. Relatively abundant shallow and ID Slim hole data define a large anomaly in an area where there may be relatively abundant fracturing and fault offsets. 265°F has been measured at 1,811 ft.  |
| PUM00 | Pumpernickel Valley               | Tipton Ranch/Hot Springs Ranch | Figure PUM00-2. The maximum measured temperature is 219°F at 3,071 ft (flowing well). This and the hot spring chalcedony temperature of 257°F establish a likely minimum condition at depth. Very low Cl in the hot spring water tempers any possibility of temperatures above about 350°F. The Area value used is poorly constrained; it could be larger, and default values of thickness are used. If the resource is assumed to have a fixed temperature of 219°F, and all other paramters are unchanged, then the Min. is 5.2 MW, the Mlk is 7.3 MW, the Mean is 11.0 MW, and the Std.Dev is 4.9 |
| PYR00 | Pyramid Lake Indian Reserv.       |                                | (Needle Rocks Hot Springs) Figure PYR00-2. Temperatures higher than 240°F (known production at roughly 4,000 and/or 5,800 ft) are suggested by chemical geothermometers but not yet confirmed. Higher tempertures could be much deeper. Area is not constrained and could be significantly larger. Represents only the Needles H.S. area and does not include any estimates for Pyramid Island or Anaho Island (Figure PYR00-1). If temperature is fixed at 240°F and all other input parameters remain unchanged, then Min is 5.2 MW, Mlk is 7.8 MW, Mean is 11 MW and Std.Dev is 4.8 MW.           |
| RYE01 | Rye Patch-Humboldt House District | Rye Patch                      | Figure RYE01-1. The estimate assumes a minimum average temperature that is the average of shallow production at c.260°F and deeper production at 405°F. Higher capacity may be possible if enough deeper hot zones can be successfully drilled, so higher default temperatures have been used for the most-likely and maximum values..   |
| RYE02 | Rye Patch-Humboldt House District | Humboldt House                 | Figure RYE02-1. Largely dependent upon default values. Area is given by shallow and deep drilling results, but the distribution of permeability is uncertain (both deep holes were apparently dry or sub-commercial). Capacity could be less if permeability is restricted to the N half of the anomaly, where the most extensive part of the outflow zone is defined by shallow temperatures and hydrothermal silica deposits.  |

| <i>PROJ ID</i>                                      | <i>Field or District</i>   | <i>Area or Power Plant</i> | <i>Comments/Notes</i>  |
|---|----------------------------|----------------------------|--|
| SAW00   | Salt Wells                 | Eight Mile Flat            | Figure SAW00-2. The relatively high estimated capacity is mostly due to the large area of the shallow thermal anomaly, which may over-represent the deep anomaly. Shallow temperatures that reach 264°F at 400 ft and (very limited) chemical information encourage the possibility of high temperatures ( $\geq 400^\circ\text{F}$ ) at depth. Deep permeability (and reservoir thickness) has to be assumed. The only deep hole, drilled within the area of the shallow thermal anomaly, encountered sub-commercial permeability and a maximum 358°F (at 8,500 ft). More deep exploration is needed. |
| SOD00   | Soda Lake                  | Soda Lake No.1/No.2        | Figure SOD00-4. System temperatures and geometry are reasonably well-established. A large number of wells have been drilled in the area, and the number in production is a relatively small fraction of the total. This suggests that it has been difficult to find adequate permeability at depth.  |
| STE00   | Steamboat Hot Sprs         | Field-wide Summary         | Figure STE00-4. Based on relatively good and complete data. The minimum recovery factor has been adjusted upwards from the normal value used for reservoirs in fractured rocks, because permeability and rate of thermal recharge appear to be very large. Recovery could still be under-estimated. The histogram of estimation frequency has a very broad maximum, which makes the most-likely (modal) estimate relatively non-unique.  |
| STI00   | Stillwater                 | Stillwater Geothermal 1    | Figure STI00-2. Good temperature data. The reservoir Area requires some rough estimation, but a large error is unlikely. Since this is a heat-in-place estimate, it does not factor in the natural thermal recharge to the area, which probably comes from the N. The histogram of frequency of estimates has a very broad maximum, which makes the most-likely (modal) estimate relatively non-unique. See separate estimate for Stillwater N expansion (STI01).  |
| STI01   | Stillwater                 | Stillwater N Expansion     | Figure STI01-1. This area is hotter and apparently closer to upflow than is the Stillwater Geothermal I area (STI00). The histogram of frequency of estimates has a very broad maximum, which makes the most-likely (modal) estimate from a single (set of) calculation(s) very non-unique. The most-likely value tabulated here (24 MW) is the average mode of 10 calculations, instead of the 33 MW value on Figure STI01-1 (which represents a single calculation).   |
| TRI00   | Trinity Mountains District | Telephone Well area        | Figure TRI00-3. Based on default values except the area of a poorly bounded shallow temperature gradient anomaly defined by values of 5.3° to 8.9°F/100 ft. Therefore, very highly uncertain.  |
| WAB00   | Wabuska                    |                            | Figure WAB00-1. The major uncertainty is reservoir thickness and whether permeability exists at depths below 2,200 ft. The existence of somewhat higher temperatures than being produced is indicated with reasonable confidence by chemical geothermometers   |
| <b><i>Area: 2 - NV with direct access to CA</i></b> |                            |                            |  |
| AUR00   | Aurora                     |                            | Figure AUR00-3. Capacity may be considerably less if the area and/or most-likely and maximum average temperatures have been over-estimated. The estimated area is based on widely separated holes that may not represent a single continuous hydrothermal system. The only confirmed temperature is c.250°F, at 1,500 ft depth.  |

| <i>PROJ ID</i> | <i>Field or District</i> | <i>Area or Power Plant</i>         | <i>Comments/Notes</i>   |
|----------------|--------------------------|------------------------------------|---|
| DIX00          | Dixie Valley             | Caithness Dixie Valley             | Figure DIX00-6. This capacity estimate is based on relatively good and complete data. It has been restricted to represent the zone of deep, hot permeability occupied by the existing production/injection wellfield, at temperatures $\geq 400^{\circ}\text{F}$ . An outer volume of (deep) rock to the SE at temperatures $< 400^{\circ}\text{F}$ is effectively not included, and significant additional deep heat reserves can be expected to exist to the NW, in the footwall (W side) of the Dixie Valley fault, where temperatures $> 400^{\circ}\text{F}$ probably are present (no deep drilling done). Therefore, this capacity estimate is conservative relative to a total heat-in-place estimate. This estimate represents reserves to the NE of a line drawn from NW to SE through the middles of Sections 11, 13 and 19 (Figure DIX00-1). The histogram of estimated values has a broad maximum, which makes the most-likely value relatively non-unique. A separate capacity estimate for the Dixie Valley Power Partners area to the SW is listed under |
| DIX01          | Dixie Valley             | Dixie Valley Power Partners (DVPP) | Figure DIX01-1. The histogram of estimated values has a broad maximum, which makes the most-likely value relatively non-unique. This estimate represents reserves to the SE of a line drawn from NW to SE through the middles of Sections 11, 13 and 19 (Figure DIX00-1). A separate capacity estimate for the Caithness Dixie Valley Project area to the NE is listed under DIX00. Even though somewhat adjusted for the possibility of permeable conditions along the front of the Stillwater Range in the central part of the area (see discussion of Area used for input to estimate calculation), this estimate may far exceed developable reserves if distributed commercial levels of permeability are not established or EGS development cannot access the total hot rock volume in the capacity estimate model. Otherwise, this estimate is based on relatively good data concerning temperature and system geometry.  |
| EMI00          | Emigrant (Fish Lake V.)  |                                    | Figure EMI00-3. High gradients and bottom hole temperatures in holes 100 ft to 2,400 ft deep extend over a large area. The most-likely average temperature that has been used for the estimate ( $340^{\circ}\text{F}$ ) appears to be reasonable and may be a little low, considering the temperatures in deep wells of the near-by Fish Lake Valley project (FIS00).  |
| FIS00          | Fish Lake (Valley)       |                                    | Figure FIS00-2. Productive wells have been drilled and successfully tested (test data is not in the public domain). The resource appears to be relatively deep and the area of the reservoir is fairly uncertain.   |
| HAW00          | Hawthorne                |                                    | Figure HAW00-4. Based on limited data and relatively uncertain, but evidence of a large, high-temperature system is thus-far lacking.   |
| HYD00          | Hyder Hot Springs        |                                    | Figure HYD00-2. This estimate is largely dependent upon default values for the input parameters, except for temperature. The minimum estimated average deep temperature is less than $200^{\circ}\text{F}$ , and the presence of significantly higher temperature is relatively uncertain.  |
| PIR00          | Pirouette Mountain       | (S.Dixie Valley)                   | Figure PIR00-2. Relatively uncertain. The maximum temperature measured is $189^{\circ}\text{F}$ at 2,000 ft., but there are elevated temperature gradients at depths as great as 2,000 ft over a large area. Seven holes already drilled to c.2,000 ft.   |
| SIL00          | Silver Peak              | (Alum prospect)                    | Figure SIL00-3. Highly uncertain. Shallow permeability and temperatures to $245^{\circ}\text{F}$ have been established. It is assumed that a single water sample correctly indicates that a higher temperature system lies at depth. Area is estimated from moderate temperature gradients to 2,000 ft at only a few points, that do not provide very good or convincing definition of the extent of the anomaly. Reservoir thickness has been assumed using default average Nevada values.   |

| <i>PROJ ID</i>                | <i>Field or District</i>      | <i>Area or Power Plant</i>        | <i>Comments/Notes</i>  |
|-------------------------------|-------------------------------|-----------------------------------|--|
| SOH00                         | Sou Hot Springs               | (Seven Devils/<br>Gilbert's H.S.) | Figure SOH00-2. Spring chemistry makes it doubtful that high temperatures are present. Otherwise, based on default values.   |
| <i>Area: 3 - Other NV</i>     |                               |                                   |  |
| BAL00                         | Baltazor                      |                                   | Figure BAL00-4. The size of the resource is not well-constrained by available drilling data. If the top of the reservoir (except for the discharge zone to the hot springs) is indeed at about 5,000 ft, drilling costs may be high relative to the modest resource temperature.   |
| DOU00                         | Double - Black Rk Hot Springs |                                   | Figure DOU00-2. The capacity is the sum of 4 separate (but possibly connected) hot spring areas that are distributed N-S along 13 miles of a tectonic lineament. Development of more than about 5 - 10 MW at any one area may not be feasible. Note that the most-likely temperature is only 255°F.  |
| MCG00                         | McGee Mountain                | (Painted Hills)                   | Figure MCG00-2. Estimate depends upon default values except for area, which is not well-constrained to the SW. The maximum temperature measured downhole is 208°F at 279 ft.. The deepest known hole has 200°F at 1,680 ft, with a bottom hole gradient of 5.2°F/100 ft. Minor fumarolic activity. Assigned to Exploration-Development Category C because 208°F exceeds boiling temperature at local elevation.  |
| PIN00                         | Pinto Hot Springs             |                                   | Figure PIN00-2. Spring chemistry offers some promise of temperatures around 350°F, but high spring flow rates at temperatures just below boiling and bicarbonate in excess of Cl add some caution to the estimate. The Area value used is based only on hot spring distribution, and could be significantly less than the true resource area. TG drilling has been done only close to the hot springs, and is no guide.  |
| SHO00                         | Shoshone-Reese River          |                                   | Figure SOH00-2. There is a large area of anomalous temperature gradients to a maximum depth of 500 ft, but the resource area has been estimated conservatively, because much of the anomaly could be an outflow zone. Otherwise, the capacity estimate is based almost entirely on default input parameters. The highest measured temperature is 155°F at 450 ft. A blind anomaly.   |
| WIL00                         | Wilson Hot Springs            |                                   | Figure WIL00-1. Very dependent upon default values except for area. No spring chemistry. Highest measured temperature is 196°F. An ID Slim hole has isothermal conditions at 193°-190°F from 1,200 to 2,000 ft.  |
| <i>Area: 4 - All other CA</i> |                               |                                   |  |
| BRW01                         | Brawley                       | Brawley (North<br>Brawley)        | Figure BRW01-2. Based on relatively good data from commercially productive wells, but these are confined to a small area and there is considerable uncertainty about the horizontal extent of the resource. The estimate defines the area that has been drilled and found to have enough permeability to flow, but it includes hot wells with sub-commercial flow rates (not dry holes). A much larger and more extensive heat resource undoubtedly exists, to the sides, above and (especially) below. The (North) Brawley resource is at depths intermediate between the shallower Salton Sea resource and the deeper resources at East Brawley and South Brawley. The brine TDS is hypersaline, as at the Salton Sea and South Brawley, but includes decidedly lower salinities (down to c.50,000 ppm, probably at the shallower production zones). |

| <i>PROJ ID</i> | <i>Field or District</i> | <i>Area or Power Plant</i>        | <i>Comments/Notes</i>   |
|----------------|--------------------------|-----------------------------------|---|
| BRW02          | Brawley                  | East Brawley                      | Figure BRW02-3. Very uncertain. There are public data records of two apparently very productive wells about 3.5 miles apart, but it is unknown whether the area in-between is a continuous, potentially productive system. Even if so, there is no particular constraint (among available data) on the horizontal extent of the reservoir. The estimated power density of the area is about 40 MW/sq mile (most-likely value; see Figure BRW02-3). Heat-in-place at depths of less than c.8,500 ft is not included in the estimate, because shallower permeability is apparently limited. If it is possible to inject at shallower levels, additional heat may be available. The reservoir may be somewhat less hypersaline than at the Salton Sea (project SAL00), with TDS about 160,000 ppm, but possibly with higher dissolved CO <sub>2</sub> (c.1.5 to 2%?). It also is deeper (>8,500 ft to c.14,000 ft).  |
| BRW03          | Brawley                  | South Brawley<br>(Mesquite field) | Figure BRW03-3. May be a significant under-estimate. The calculated capacity that is listed here corresponds only to the area drilled and tested by MCR during 1979-82 (about 1.8 sq miles), because there is no information that establishes the horizontal limit of the reservoir. The reservoir area could be much larger. If, for example, it occupies much of the seismically active region of the South Brawley KGRA between the Imperial and Brawley faults (Figure BRW03-2), then the area could be as large as c.30 sq miles, which would increase the estimated modal generation capacity to over 800 MW. The estimated power density of the area is about 28 MW/sq mile (most-likely value; see Figure BRW03-3). Heat-in-place at depths of less than c.11,000 ft is not included in the estimate, because shallower permeability is apparently limited. If it is possible to inject at shallower levels, additional heat may be available. The reservoir is hypersaline as at the Salton Sea (project SAL00), but much deeper (>11,000 ft; Figure BRW00-2) and with much higher dissolved CO <sub>2</sub> and heavy metals. The result may be a combination of higher scaling and corrosion tendency and higher development and operations costs. |
| CAL00          | Calistoga                |                                   | Figure CAL00-4. Relatively uncertain, in spite of abundant shallow well data. The maximum depth drilled has been about 2,000 ft and there are very few holes deeper than about 600 ft. Upflow into the shallow aquifer is believed to occur along an axis (probably a fault or fracture zone) that coincides with the geographic center of the NW-SE trending Napa Valley. Locations of relatively high temperatures (>250°F) in the shallow system occur near the NW and SE ends of this axis, at a separation of about 1.8 miles. The generation estimate assumes that there is a reservoir at depths greater than 2,000 ft, and average temperatures as high as 320°F, that connects and surrounds these two locations and feeds the shallow aquifer. The 320°F estimate is given by the Na-K-Ca thermometer without an Mg correction. Default values have been used for estimated reservoir thickness. Deep exploration and electrification development would seem unlikely, due to extensive use of the shallow aquifer and intense development (commercial, agricultural and residential) in the Calistoga area.  |
| COS00          | Coso                     | Field-wide Summary                | Figure COS00-2. Based on a relatively good understanding and definition of the resource. The histogram of estimated values has a broad maximum, which makes the most-likely value relatively non-unique. Figure COS00-3 shows that the Coso field has generally maintained power output in the range of 260 to 300 MW gross since the ninth turbogenerator unit went on-line in 1990.   |
| DUN00          | Dunes                    |                                   | Figure DUN00-4. Shallow gradient drilling appears to limit the size of the temperature anomaly but a lack of deep information makes the estimate relatively uncertain. For example, although Figure DUN00-3 shows a model of the system that places the deep reservoir beneath the shallow anomaly, this anomaly could instead be the outflow of a deeper and hotter  |
| EAS00          | East Mesa                | Field-wide summary                | Figure EAS00-5. Based on relatively complete and reliable data, but operators apparently have had difficulty maintaining production at the installed capacity of 73 MW. The principal uncertainty is reservoir thickness.   |

|       |         |                    |   |
|-------|---------|--------------------|---|
| GEY00 | Geysers | Field-wide Summary | <p>This Estimated Generation Capacity for The Geysers does NOT represent application of the heat-in-place method and Monte Carlo simulation. Instead, the estimate is based on the following:</p> <p>A) As of 2002, the installed power capacity at The Geysers was approximately 1,000 MW gross, and the annual decline rate of generation was on the order of 5%. It is assumed that this amount of decline can be mitigated by working over existing wells, drilling new wells and undertaking modifications to the power plant and gathering systems. Once the injection of effluent from the City of Santa Rosa commences, this decline trend is expected to be somewhat reduced. Therefore, maintaining the present installed capacity of about 1,000 MW gross at The Geysers for the next two decades should be relatively inexpensive and straightforward.</p> <p>B) The total proven reservoir area at The Geysers is nearly 40 square miles, as determined by the extensive shallow and deep well drilling in the region. Of this area, there is a portion of approximately 10 square miles, which has never been developed for continuous steam supply. This 10 square miles, lying between the Aidlin project area to the northwest and the areas of Units 5-6, 7-8 and 11 to the southeast, comprises about 25% of the 40 square mile total proven area. Given that an installed capacity of 1,000 MW gross is being supported at a steady state by some 30 square miles of the field area, a reasonable estimate of average installed capacity is 33 MW per square mile. Therefore, the un-utilized 10 square miles should be able to support 333 MW gross of additional capacity.</p> <p>C) In addition, about 2 square miles in the northeastern part of the field (within the proven reservoir area) remain untapped, at the former Bottlerock project and a contiguous area to the southeast. Using the factor of 33 MW gross per square mile, this area would support another 66 MW gross of additional capacity.</p> <p>D) Therefore, the maximum possible capacity of The Geysers is estimated to be approximately (1,000+333+66) or about 1,400 MW gross (which includes existing power plants). This is listed herein as both the Most-likely value and the Mean value.</p> <p>E) A minimum value for the incremental power available would be about half of the estimate based on 33 MW per square mile, or 200 MW above current generation levels. Therefore, the minimum installed capacity at The Geysers over the next two decades is about (1,000+200) or 1,200 MW gross: this is listed herein as the Minimum value.</p> <p>F) If energy prices increase, operators of existing plants would have an incentive to invest in further facility optimization, which could yield an additional 10% of capacity at existing plants, or 100 MW. Thus, the total capacity of the Geysers could easily reach 1500 MW gross under the right economic conditions.</p> <p>N1) Since the MW estimates are not based on a Monte-Carlo heat-in-place calculation, there is no corresponding standard deviation value.</p> |
| GLA00 | Glamis  |                    | <p>Figure GLA00-1. Based on no significant data other than a single hot (132°F) gradient hole. Only a few shallow holes have been drilled in the area. Data from a 2,000 ft hole were not found. This estimate is therefore very uncertain.</p>   |

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|----------------|-----------------------------|----------------------------|---|
| HEB00          | Heber                       | Field-wide Summary         | Figure HEB00-3. Based on relatively good and complete data. Reservoir thickness has been largely confined to the thickness being exploited and known to be sufficiently permeable for production. A larger amount of heat-in-place (and higher capacity) would be calculated by adding the hot rock (below about 6,500 ft depth) which underlies production wells in the SIGC area, outside of the central hot core of the system; however, the deep rock in this (SIGC) area may have relatively low   |
| LAK00          | Lake City / Surprise Valley | Lake City                  | Figure LAK00-4. In spite of one successful well (2-3 MW production), the thickness and extent of the reservoir remain very uncertain.   |
| LVM00          | Long Valley - M-P Leases    | M-P Lease Summary          | Figure LVM00-6. The geothermal resource at Casa Diablo has a very high permeability and a high natural recharge rate. This is not explicitly reflected in the heat-in-place method, which neglects the addition of heat to the exploited reservoir volume in the time frame of commercial development. The assumed 5% default minimum recovery factor is therefore likely to be conservative, and the generation capacity of the area may be greater than the minimum (90% probable) estimate.  |
| MED01          | Medicine Lake               | Fourmile Hill              | <p>1) This estimate (Figure MED01-2) is based on relatively limited information. There is just one deep exploration well (TD 8,503 ft) and no publically available samples of the geothermal fluid. There is one ID slim hole (TD 4,416 ft.), with a maximum temperature of 455°F and a temperature profile that suggests permeable, convective conditions below about 3,000 ft depth. The deep exploration hole shows some permeability at c.6,000 ft and a temperature reversal below c.4,000 ft (T.Box, pers.comm. 25 July 03).</p> <p>2) The generation capacity estimate herein does not use a most-likely (Mlk) estimate of reservoir area, only a minimum and a maximum. It is felt that inadequate information is available to estimate the Mlk area.</p>   |
| MED02          | Medicine Lake               | Telephone Flat             | <p>1) This estimate (Figure MED02-1) is based on relatively good information, as there are three deep, full-diameter wells that have been drilled and tested. The most-uncertain parameter is reservoir area. A reasonable minimum area is provided by the distribution of the three wells. A much larger maximum possible area is given by the location of the shallow, 38°C/100°F isotherm at 1500 m elevation (Figure MED00-1). However, the correlation of this isotherm with the boundary of the deep reservoir is not established with confidence. For the purposes of reserves associated with Telephone Flat, a 9 sq mi area in the vicinity of the proposed power plant is being used.</p> <p>2) A reservoir volume number is not provided, because reservoir volume is calculated from most-likely area and most-likely thickness, but the generation capacity estimate herein does not use a most-likely (Mlk) estimate of reservoir area, only a minimum and a maximum. It is felt that inadequate information is available to estimate the Mlk area.</p> <p>3) BLM99a, p.ES37 states that "The Supplemental Environmental Assessment (EA) for geothermal leasing in the Glass Mountain KGRA provided an estimation of the electric-generation potential of the Glass Mountain KGRA to be about 550 MW for a 30-year period. However, this estimation was based on indirect information with very limited geothermal resource data obtained from only a few deep temperature gradient holes in the area. More recent information suggests that the actual commercial development potential of the Glass Mountain KGRA is far less than earlier projected." The factual basis for this comment is not given.</p> |

***PROJ ID Field or District Area or Power Plant Comments/Notes***

|       |                   |                    |  |
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| MOS00 | Mount Signal      |                    | Figure MOS00-3. Based on relatively good data from temperature gradient holes and one ID Slim hole (to 1826 ft, BHT 259°F). No fluids samples (apparently a blind anomaly). Represents only the part of the anomaly that is within the U.S.  |
| NIL00 | Niland            |                    | Figure NIL00-1. This capacity estimate is confined to the area that was drilled and (it has been reported) successfully tested in the early 1980s. Evidence suggests that the Niland resource is the eastern-most edge of the Salton Sea system, although the Niland wells are located about 1 mile east of the shallow heat flow anomaly shown on Figures SAL00-1 and -2, and permeability at Niland is deeper than in the Salton Sea reservoir (see Figure BRW00-2). Deep, hot rock at temperatures similar to those encountered at Niland probably extends across a much larger area, at a power density of about 32 MW/sq mile (minimum estimate).   |
| RAN00 | Randsburg         |                    | Figure RAN00-2. Highly uncertain. The shallow temperature anomaly is well-defined, but the actual temperature, thickness and area of the resource are largely assigned default values. There are no chemical data. The highest measured temperature reported is 239°F at 772 ft. Results of drilling by Phillips in 1981 are not in the public domain.   |
| SAL00 | Salton Sea        | Field-wide summary | <p>Figure SAL00-3. This estimate, which is based on relatively good and complete data, represents an area of 18.1 sq miles within the shallow gradient anomaly (Figures SAL00-1 and -2) that is on-shore or can reasonably be reached by directional drilling from on-shore at this time. The total shallow gradient anomaly is some 28 sq miles, and if scaled to that value, the Min (90% probable) value of generation capacity would become 2090 MW. The histogram which is the frequency of generation estimates (on Figure SAL00-3) has a relatively broad maximum, which means that the most-likely (modal) estimate is relatively non-unique.</p> <p>For comparison, a recent published estimate of the generation capacity of the geothermal field can be summarized as follows:</p> <p>A) Hulen and others (2002) (Hul02a) have estimated the area of the Salton Sea resource based on the 11°F/100ft (200°C/km) shallow temperature gradient contour, which has been defined by more than 100 shallow boreholes and deep geothermal wells (Figure SAL00-1). The area inside this contour is estimated by Hul02a to be 72.4 square km, or 28 square miles (sqmi).</p> <p>B) The estimation method used by Hul02a is to divide the existing developed production capacity (335 MWe) by the land area that has been extensively drilled to support this capacity (4.0 sq mi), to obtain a MWe/sqmi value, and then scale this value up to 28 sqmi. Accordingly, <math>(335/4.0) = 83.7</math> MWe/sqmi, and <math>28 \text{ sqmi} * 83.7 \text{ MWe/sqmi} = 2330 \text{ MWe}</math> (see Figure SAL00-2). Hul02a estimates the onshore resource of the Salton Sea as having a potential of 900 MWe, which is within the range of the minimum and most-likely estimates presented in this database.</p> |
| SES00 | Sespe Hot Springs |                    | Figure SES00-1. Based on default values for a non-volcanic system, except for temperatures from hot spring chemistry (3 samples, all very similar).  |

| <i>PROJ ID</i> | <i>Field or District</i> | <i>Area or Power Plant</i> | <i>Comments/Notes</i>  |
|----------------|--------------------------|----------------------------|--|
| SUL00          | Sulphur Bank             | Clear Lake                 | Figure SUL00-5. Deep drilling data indicate widespread temperatures $\geq 425^{\circ}\text{F}$ at depths of 4,000 to 7,000 ft., that are associated with a volcanic heat source. The distribution of deep permeability is uncertain. A commercially productive well former Sulphur Bank mercury mine. This well found production of water at about $425^{\circ}\text{F}$ from a depth of 1,625 ft. Relatively shallow permeability may be confined to SW-NE and/or E-W-trending fault/fracture zones that have been the locus of the mercury and sulfur deposit that was exploited by the mine. However, the amounts of historic hot spring activity at the site, and the size of the mercury deposit, suggest hydrologic communication with a much larger volume of rock than would be contained by these fault/fracture zones alone. |
| SUP00          | Superstition Mountain    |                            | Figure SUP00-3. Except for area, this calculation is based on default values for Nevada Basin and Range resources, and the applicability of these defaults to this setting is uncertain. Area is based on isotherms at 200 ft depth (maximum $110^{\circ}\text{F}$ ), and is also relatively uncertain.  |



**Hetch Hetchy/SFPUC Programmatic Renewable Energy Project**  
**Project: 1.3 New Geothermal Site Identification and Qualification**  
**Project Team: GeothermEx, Inc.**  
**Task: 1.3.10 Final Project Report**  
**Subject: D.1.3.10.3 Final Report**

***Table 5: Estimated Generation Capacities - by Exploration-Development Category***

| PROJ<br>ID                                    | Field or District        | Area or<br>Power Plant | State | County        | Temperature (°F) <sup>1</sup> |      |      | Volume <sup>2</sup><br>(mi <sup>3</sup> ) | Installed <sup>3</sup><br>Capacity (MW) |      | Explor-<br>Devel.<br>Cat. <sup>4</sup> | Generation Capacity (MW-30yrs) <sup>5</sup> |      |      |      |
|---|--------------------------|------------------------|-------|---------------|-------------------------------|------|------|---|---|------|--|---|------|------|------|
|   |                          |                        |       |               | Min                           | Mlk  | Max  |   | Gross                                   | -    |  | Net   | Min  | Mlk  | Mean |
| Category: A - Existing power plant operating. |                          |                        |       |               |                               |      |      |   |   |      |  |   |      |      |      |
| BEO00   | Beowawe                  |                        | NV    | Eureka-Lander | 400°                          | 410° | 420° | 1.70                                      | 16.7                                    | 16   | A                                      | 30  | 41   | 58   | 21   |
| BRA00   | Brady's Hot Springs      |                        | NV    | Churchill     | 340°                          | 360° | 380° | 0.76                                      | 26                                      | 20   | A                                      | 11  | 18   | 22   | 8.3  |
| COS00   | Coso                     | Field-wide Summary     | CA    | Inyo          | 475°                          | 550° | 575° | 8.52                                      | 300                                     | 270  | A                                      | 246   | 355  | 490  | 189  |
| DES00   | Desert Peak              |                        | NV    | Churchill     | 370°                          | 385° | 400° | 2.27                                      | 11                                      | 9.9  | A                                      | 33  | 45   | 79   | 40   |
| DIX00   | Dixie Valley             | Caithness Dixie Valley | NV    | Churchill     | 420°                          | 440° | 460° | 3.17                                      | 66                                      | 56   | A                                      | 71  | 107  | 142  | 56   |
| EAS00   | East Mesa                | Field-wide summary     | CA    | Imperial      | 300°                          | 310° | 320° | 8.54                                      | 73.2                                    | 56   | A                                      | 119   | 148  | 167  | 38   |
| EMP00   | Empire (San Emidio)      | Field-wide summary     | NV    | Washoe        | 285°                          | 305° | 330° | 0.62                                      | 4.8                                     | 4.6  | A                                      | 4.3   | 6.6  | 11   | 6.7  |
| GEY00   | Geysers                  | Field-wide Summary     | CA    | Lake-Sonoma   | 464°                          | 468° | 482° | 37.88                                     | 1000                                    | 900  | A                                      | 1200  | 1400 | 1400 | N1   |
| HEB00   | Heber                    | Field-wide Summary     | CA    | Imperial      | 330°                          | 340° | 360° | 6.73                                      | 100                                     | 79   | A                                      | 109   | 142  | 158  | 40   |
| HON00   | Honey Lake               | Area-wide Summary      | CA    | Lassen        | 230°                          | 240° | 250° | 1.09                                      | 6.4                                     | 3.4  | A                                      | 5.7   | 8.3  | 13   | 6.9  |
| LVM00   | Long Valley - M-P Leases | M-P Lease Summary      | CA    | Mono          | 342°                          | 362° | 382° | 8.18                                      | 40                                      | 30.1 | A                                      | 70  | 111  | 148  | 65   |
| SAL00   | Salton Sea               | Field-wide summary     | CA    | Imperial      | 550°                          | 575° | 600° | 25.71                                     | 350                                     | 326  | A                                      | 1350  | 1750 | 1880 | 400  |
| SOD00   | Soda Lake                | Soda Lake No.1/No.2    | NV    | Churchill     | 340°                          | 360° | 370° | 2.12                                      | 26.1                                    | 16.6 | A                                      | 29  | 42   | 62   | 28   |
| STE00   | Steamboat Hot Sprs       | Field-wide Summary     | NV    | Washoe        | 350°                          | 370° | 390° | 2.33                                      | 59.84                                   | 48.1 | A                                      | 56  | 62   | 78   | 17   |

| PROJ<br>ID                  | Field or District | Area or<br>Power Plant  | State | County    | <u>Temperature (°F)</u> <sup>1</sup> |      |      | <u>Volume</u> <sup>2</sup><br>(mi <sup>3</sup> ) | <u>Installed</u> <sup>3</sup><br><u>Capacity (MW)</u> |       | <u>Explor-<br/>Devel.</u><br>Cat. <sup>4</sup> | <u>Generation Capacity (MW-30yrs)</u> <sup>5</sup> |      |      |                  |
|-----------------------------|-------------------|-------------------------|-------|-----------|--------------------------------------|------|------|--|---|-------|--|--|------|------|------------------|
|                             |                   |                         |       |           | Min                                  | MLk  | Max  |  | Gross   | - Net |  | Min  | MLk  | Mean | Std. Dev.        |
| STI00                       | Stillwater        | Stillwater Geothermal 1 | NV    | Churchill | 290°                                 | 310° | 330° | 1.09   | 19  | 10    | A  | 11   | 18   | 21   | 8.0              |
| WAB00                       | Wabuska           |                         | NV    | Lyon      | 225°                                 | 245° | 290° | 1.33   | 1.45  | 1.2   | A  | 8.1  | 13   | 17   | 8.0              |
| <b>Totals for Category:</b> |                   |                         |       |           |                                      |      |      |  | 2100  | 1847  |  | 3353   | 4267 | 4746 | 458 <sup>6</sup> |

**Category: B - One or more wells tested at >=1 MW.**

|                             |                                      |                                   |    |           |      |      |      |      |      |      |   |     |     |      |                  |
|-----------------------------|--------------------------------------|-----------------------------------|----|-----------|------|------|------|------|------|------|---|-----|-----|------|------------------|
| BRW01                       | Brawley                              | Brawley (North Brawley)           | CA | Imperial  | 490° | 510° | 530° | 2.45 | 0    | -    | B | 88  | 135 | 144  | 45               |
| BRW02                       | Brawley                              | East Brawley                      | CA | Imperial  | 480° | 520° | 560° | 2.21 | 0    | -    | B | 85  | 129 | 138  | 44               |
| BRW03                       | Brawley                              | South Brawley<br>(Mesquite field) | CA | Imperial  | 480° | 500° | 520° | 1.19 | 0    | -    | B | 45  | 62  | 70   | 21               |
| FIS00                       | Fish Lake (Valley)                   |                                   | NV | Esmeralda | 340° |      | 380° | 2.25 | 0    | -    | B | 30  | 47  | 62   | 27               |
| LAK00                       | Lake City / Surprise<br>Valley       | Lake City                         | CA | Modoc     | 320° | 335° | 350° | 2.18 | 0    | -    | B | 23  | 37  | 49   | 21               |
| MED01                       | Medicine Lake                        | Fourmile Hill                     | CA | Siskiyou  | 388° | 428° | 455° | 2.05 | 0    | -    | B | 25  | 36  | 70   | 42               |
| MED02                       | Medicine Lake                        | Telephone Flat                    | CA | Siskiyou  | 440° | 480° | 490° | 5.05 | 0    | -    | B | 110 | 175 | 256  | 128              |
| NIL00                       | Niland                               |                                   | CA | Imperial  | 500° | 540° | 550° | 1.39 | 0    | -    | B | 59  | 76  | 92   | 27               |
| RYE01                       | Rye Patch-Humboldt<br>House District | Rye Patch                         | NV | Pershing  | 335° | 345° | 405° | 1.13 | 12.5 | 8.75 | B | 16  | 20  | 34   | 15               |
| STI01                       | Stillwater                           | Stillwater N Expansion            | NV | Churchill | 310° | 330° | 350° | 1.36 | 0    | -    | B | 16  | 24  | 31   | 11               |
| SUL00                       | Sulphur Bank                         | Clear Lake                        | CA | Lake      | 400° |      | 450° | 1.66 | 0    | -    | B | 27  | 43  | 61   | 30               |
| <b>Totals for Category:</b> |                                      |                                   |    |           |      |      |      |      | 13   | 9    |   | 524 | 784 | 1007 | 160 <sup>6</sup> |

**Category: C - Minimum 212°F logged downhole.**

|       |               |  |    |          |      |      |      |      |   |   |   |    |    |    |    |
|-------|---------------|--|----|----------|------|------|------|------|---|---|---|----|----|----|----|
| AUR00 | Aurora        |  | NV | Mineral  | 250° | 345° | 440° | 2.65 | 0 | - | C | 31 | 51 | 70 | 35 |
| BAL00 | Baltazor      |  | NV | Humboldt | 288° | 306° | 316° | 1.19 | 0 | - | C | 11 | 16 | 24 | 11 |
| BLU00 | Blue Mountain |  | NV | Humboldt | 291° | 345° | 440° | 1.33 | 0 | - | C | 16 | 30 | 38 | 19 |
| CAL00 | Calistoga     |  | CA | Napa     | 275° |      | 320° | 1.86 | 0 | - | C | 17 | 25 | 35 | 16 |

| <i>PROJ<br/>ID</i> | <i>Field or District</i>        | <i>Area or<br/>Power Plant</i>     | <i>State County</i> | <i>Temperature (°F)</i> <sup>1</sup> |            |            | <i>Volume</i> <sup>2</sup><br><i>(mi<sup>3</sup>)</i> | <i>Installed</i> <sup>3</sup><br><i>Capacity (MW)</i> |          |            | <i>Explor-<br/>Devel.<br/>Cat.</i> <sup>4</sup> | <i>Generation Capacity (MW-30yrs)</i> <sup>5</sup> |            |             |                  |
|--------------------|---------------------------------|------------------------------------|---------------------|--------------------------------------|------------|------------|---|---|----------|------------|---|--|------------|-------------|------------------|
|                    |                                 |                                    |                     | <i>Min</i>                           | <i>Mid</i> | <i>Max</i> |   | <i>Gross</i>  | <i>-</i> | <i>Net</i> |   | <i>Min</i>   | <i>Mid</i> | <i>Mean</i> | <i>Std. Dev.</i> |
| COL00              | Colado                          |                                    | NV Pershing         | 215°                                 | 270°       | 330°       | 0.80  | 0   | -        | C          |   | 3.7  | 6.2        | 8.3         | 4.1              |
| DIX01              | Dixie Valley                    | Dixie Valley Power Partners (DVPP) | NV Churchill        | 445°                                 | 460°       | 475°       | 4.69  | 0   | -        | C          |   | 107  | 151        | 210         | 83               |
| DUN00              | Dunes                           |                                    | CA Imperial         | 250°                                 |            | 400°       | 0.86  | 0   | -        | C          |   | 7.4  | 11         | 18          | 10               |
| EMI00              | Emigrant (Fish Lake V.)         |                                    | NV Esmeralda        | 230°                                 | 340°       | 450°       | 6.77  | 0   | -        | C          |   | 49   | 85         | 118         | 63               |
| FAL00              | Fallon / Carson Lake            | Carson Lake anomaly                | NV Churchill        | 360°                                 | 370°       | 380°       | 2.61  | 0   | -        | C          |   | 34   | 55         | 74          | 34               |
| FLY00              | Fly Ranch/Granite Ranch         | Ward's (Fly/Hualapi Flat) H.S.     | NV Washoe-Pershing  | 200°                                 | 220°       | 210°       | 2.40  | 0   | -        | C          |   | 6.0  | 8.7        | 13          | 5.7              |
| FLY01              | Fly Ranch/Granite Ranch         | Granite Ranch                      | NV Washoe-Pershing  | 221°                                 | 345°       | 440°       | 0.53  | 0   | -        | C          |   | 5.4  | 8.1        | 13          | 7.1              |
| GER00              | Gerlach                         | (Great Boiling Spring)             | NV Washoe           | 290°                                 | 340°       | 385°       | 2.50  | 0   | -        | C          |   | 17   | 25         | 36          | 16               |
| HAW00              | Hawthorne                       |                                    | NV Mineral          | 200°                                 | 285°       | 440°       | 1.06  | 0   | -        | C          |   | 8.7  | 14         | 22          | 13               |
| HAZ00              | Hazen (Black Butte)             | (Patua Hot Springs)                | NV Lyon             | 280°                                 | 330°       | 430°       | 1.25  | 0   | -        | C          |   | 6.3  | 8.5        | 14          | 6.9              |
| KYL00              | Kyle Hot Springs (Granite Mtn.) | (Buena Vista Valley)               | NV Pershing         | 280°                                 | 375°       | 412°       | 0.99  | 0   | -        | C          |   | 16   | 22         | 36          | 19               |
| LEA00              | Leach Hot Springs               | Grass Valley                       | NV Pershing         | 220°                                 | 265°       | 343°       | 1.79  | 0   | -        | C          |   | 13   | 18         | 29          | 15               |
| LEE00              | Lee Hot Springs                 |                                    | NV Churchill        | 303°                                 |            | 324°       | 0.53  | 0   | -        | C          |   | 5.4  | 9.4        | 11          | 5.1              |
| MCG00              | McGee Mountain                  | (Painted Hills)                    | NV Humboldt         | 225°                                 | 345°       | 440°       | 1.86  | 0   | -        | C          |   | 19   | 28         | 47          | 26               |
| MOS00              | Mount Signal                    |                                    | CA Imperial         | 250°                                 | 345°       | 440°       | 1.19  | 0   | -        | C          |   | 12   | 19         | 29          | 15               |
| NEW00              | New York Canyon                 |                                    | NV Pershing         | 245°                                 | 345°       | 440°       | 1.72  | 0   | -        | C          |   | 20   | 26         | 46          | 23               |
| NOR00              | North Valley                    |                                    | NV Churchill-Washoe | 255°                                 | 345°       | 440°       | 3.18  | 0   | -        | C          |   | 37   | 49         | 84          | 43               |
| PUM00              | Pumpernickel Valley             | Tipton Ranch/Hot Springs Ranch     | NV Humboldt         | 235°                                 | 295°       | 356°       | 1.19  | 0   | -        | C          |   | 10   | 13         | 22          | 11               |
| PYR00              | Pyramid Lake Indian Reserv.     | (Needle Rocks Hot Springs)         | NV Washoe           | 240°                                 | 345°       | 417°       | 0.93  | 0   | -        | C          |   | 9.9  | 14         | 23          | 12               |

| PROJ<br>ID   | Field or District                 | Area or<br>Power Plant        | State | County                      | <u>Temperature (°F)</u> <sup>1</sup> |      |      | <u>Volume</u> <sup>2</sup><br>(mi <sup>3</sup> ) | <u>Installed</u> <sup>3</sup><br><u>Capacity (MW)</u> |   |     | <u>Explor-<br/>Devel.</u><br>Cat. <sup>4</sup> | <u>Generation Capacity (MW-30yrs)</u> <sup>5</sup> |     |      |                  |
|--|-----------------------------------|-------------------------------|-------|-----------------------------|--------------------------------------|------|------|--|---|---|-----|--|--|-----|------|------------------|
|  |                                   |                               |       |                             | Min                                  | Mlk  | Max  |  | Gross   | - | Net |  | Min  | Mlk | Mean | Std. Dev.        |
| RAN00  | Randsburg                         |                               | CA    | San Bernardino              | 240°                                 | 345° | 440° | 3.31   | 0   | - | C   |  | 32   | 48  | 82   | 46               |
| RYE02  | Rye Patch-Humboldt House District | Humboldt House                | NV    | Pershing                    | 290°                                 | 345° | 440° | 2.12   | 0   | - | C   |  | 27   | 34  | 60   | 30               |
| SAW00  | Salt Wells                        | Eight Mile Flat               | NV    | Churchill                   | 330°                                 | 400° | 430° | 3.98   | 0   | - | C   |  | 63   | 96  | 136  | 63               |
| SIL00  | Silver Peak                       | (Alum prospect)               | NV    | Esmeralda                   | 310°                                 | 345° | 440° | 2.85   | 0   | - | C   |  | 41   | 78  | 91   | 43               |
| <b>Totals for Category:</b>                              |                                   |                               |       |                             |                                      |      |      |  | 0   |   |     |  | 625  | 949 | 1389 | 166 <sup>6</sup> |
| <b>Category: D - Other exploration data/information.</b> |                                   |                               |       |                             |                                      |      |      |  |   |   |     |  |  |     |      |                  |
| DOU00  | Double - Black Rk Hot Springs     |                               | NV    | Humboldt                    | 240°                                 | 255° | 275° | 2.12   | 0   | - | D   |  | 20   | 33  | 53   | 31               |
| GLA00  | Glamis                            |                               | CA    | Imperial                    | 250°                                 |      | 400° | 0.83   | 0   | - | D   |  | 4.3  | 6.4 | 11   | 6.0              |
| HYD00  | Hyder Hot Springs                 |                               | NV    | Pershing                    | 180°                                 |      | 310° | 1.67   | 0   | - | D   |  | 5.5  | 9.6 | 15   | 8.4              |
| PIN00  | Pinto Hot Springs                 |                               | NV    | Humboldt                    | 285°                                 | 366° | 440° | 1.33   | 0   | - | D   |  | 18   | 29  | 39   | 19               |
| PIR00  | Pirouette Mountain                | (S.Dixie Valley)              | NV    | Churchill                   | 190°                                 | 345° | 440° | 1.52   | 0   | - | D   |  | 16   | 23  | 40   | 22               |
| SES00  | Sespe Hot Springs                 |                               | CA    | Ventura                     | 230°                                 | 265° | 300° | 0.53   | 0   | - | D   |  | 3.6  | 5.3 | 7.8  | 3.6              |
| SHO00  | Shoshone-Reese River              |                               | NV    | Lander                      | 225°                                 | 345° | 440° | 1.19   | 0   | - | D   |  | 13   | 18  | 30   | 16               |
| SOH00  | Sou Hot Springs                   | (Seven Devils/Gilbert's H.S.) | NV    | Pershing                    | 180°                                 |      | 370° | 0.53   | 0   | - | D   |  | 3.3  | 6.1 | 9.5  | 6.1              |
| SUP00  | Superstition Mountain             |                               | CA    | Imperial                    | 225°                                 | 345° | 440° | 0.66   | 0   | - | D   |  | 5.9  | 9.5 | 15   | 8.0              |
| TRI00  | Trinity Mountains District        | Telephone Well area           | NV    | Church.-<br>Pers.-<br>Wash. | 225°                                 | 345° | 440° | 3.98   | 0   | - | D   |  | 42   | 66  | 100  | 53               |
| WIL00  | Wilson Hot Springs                |                               | NV    | Lyon                        | 200°                                 | 345° | 440° | 1.13   | 0   | - | D   |  | 10   | 17  | 27   | 15               |
| <b>Totals for Category:</b>                              |                                   |                               |       |                             |                                      |      |      |  | 0   |   |     |  | 142  | 223 | 347  | 73 <sup>6</sup>  |

| PROJ<br>ID    | Field or District | Area or<br>Power Plant | State | County | <u>Temperature (°F)</u> <sup>1</sup> |     |     | Volume <sup>2</sup><br>(mi <sup>3</sup> ) | <u>Installed</u> <sup>3</sup><br>Capacity (MW) |      |     | Explor-<br>Devel.<br>Cat. <sup>4</sup> | <u>Generation Capacity (MW-30yrs)</u> <sup>5</sup> |      |      |                  |
|---------------|-------------------|------------------------|-------|--------|--------------------------------------|-----|-----|---|--|------|-----|--|--|------|------|------------------|
|               |                   |                        |       |        | Min                                  | Mlk | Max |   | Gross  | -    | Net |  | Min  | Mlk  | Mean | Std. Dev.        |
| Grand Totals: |                   |                        |       |        |                                      |     |     |   | 2113   | 1856 |     |  | 4644   | 6223 | 7490 | 518 <sup>6</sup> |

1. Reservoir temperature values used for Monte-Carlo estimation of generation capacity.

Min = minimum average; Mlk = most-likely average; Max = Maximum average.

2. The listed reservoir volume is the product: (most-likely average reservoir thickness) x (most-likely reservoir area), where the most-likely values are those used for Monte-Carlo estimation of generation capacity.

3. Installed generation capacity, gross and net MW. Applies only to Exploration-Development Category A.

4. Exploration-Development Category

A = existing power plant operating

B = one or more wells tested at  $\geq 1$  MW

C = a temperature  $\geq 212^\circ\text{F}$  has been logged downhole (or boiling temperature for local elevation)

D = other exploration data (such as spring chemistry and/or shallow temperature gradient measurements)

5. Min = Minimum = generation capacity value with Monte Carlo simulation cumulative probability of more than 90%

Mlk = Most-likely = Monte Carlo simulation modal generation capacity value

Mean = Monte Carlo simulation mean value

Std.Dev. = Standard Deviation of the Mean value

6. The standard deviation of the sum of mean values is the square root of the sum of squares of individual standard deviations.



# Hetch Hetchy/SFPUC Programmatic Renewable Energy Project

**Project:** 1.3 New Geothermal Site Identification and Qualification

**Project Team:** GeothermEx, Inc.

**Task:** 1.3.10 Final Project Report

**Subject:** D.1.3.10.3 Final Report

**Table 6a: Data for Statistical Correlation of Drilling Costs vs. Depth**

| <i>Well</i>     | <i>Completion<br/>Date<br/>(estimated<br/>dates in<br/>italics)</i> | <i>Total<br/>Depth<br/>(feet)</i> | <i>Unescalated<br/>Total<br/>Cost<br/>(US\$)</i> | <i>Producer<br/>Price<br/>Index<br/>(PPI)</i> | <i>Escalation<br/>Factor to<br/>July 2003<br/>(PPI=142.0)</i> | <i>Total Cost<br/>Escalated<br/>to 2003<br/>(US\$)</i> | <i>Escalated<br/>Cost<br/>Per Foot<br/>(US\$)</i> | <i>Comments</i>   |
|-----------------|---|-----------------------------------|--|---|---|--|---|---|
| Geysers 1       | 1-Jul-94  | 11,452                            | \$2,660,000                                      | 93.0  | 1.527   | \$4,061,505  | \$355   | Cost is for first leg only.<br>Full well cost was \$3,282,000<br>including 2,193-ft fork (8,900' to 11,093').<br>Includes mob of rig to site.<br>Stacked out rig at end of job. |
| Geysers 2       | 1-Jul-92  | 9,378                             | \$2,184,000                                      | 90.3  | 1.573   | \$3,434,419  | \$366   | Cost includes \$47,000 mob,<br>but no de-mob (skidded to another well).   |
| Geysers 3       | 1-Jul-95  | 9,932                             | \$2,920,000                                      | 96.7  | 1.468   | \$4,287,901  | \$432   | Includes full mob and de-mob of rig.  |
| Geysers 4       | 1-Jul-92  | 9,670                             | \$3,764,150                                      | 90.3  | 1.573   | \$5,919,261  | \$612   | Well has 3 legs. Depth is for deepest leg.<br>Cost is for all legs, so cost per foot is high.   |
| Geysers 5       | 1-Jul-92  | 8,496                             | \$2,220,265                                      | 90.3  | 1.573   | \$3,491,447  | \$411   |   |
| Geysers 6       | 1-Jul-92  | 10,850                            | \$2,352,530                                      | 90.3  | 1.573   | \$3,699,438  | \$341   |   |
| Geysers 7       | 1-Jul-92  | 9,429                             | \$3,239,895                                      | 90.3  | 1.573   | \$5,094,851  | \$540   | Well has 3 legs.  |
| Geysers 8       | 1-Jul-86  | 7,658                             | \$822,185  | 93.0  | 1.527   | \$1,255,379  | \$164   |   |
| Geysers 9       | 1-Jul-85  | 7,471                             | \$1,186,334                                      | 100.0   | 1.420   | \$1,684,594  | \$225   |   |
| Geysers 10      | 1-Jul-86  | 10,606                            | \$2,487,327                                      | 93.0  | 1.527   | \$3,797,854  | \$358   |   |
| Geysers 11      | 1-Jul-86  | 5,588                             | \$803,584  | 93.0  | 1.527   | \$1,226,978  | \$220   |   |
| Geysers 12      | 1-Jul-88  | 9,120                             | \$1,970,296                                      | 89.7  | 1.583   | \$3,119,086  | \$342   |   |
| Geysers 13      | 1-Jul-87  | 6,849                             | \$1,418,780                                      | 87.6  | 1.621   | \$2,299,849  | \$336   |   |
|                 |   |                                   |  |   |   |  |   |   |
| Medicine Lake 1 | 7-Oct-02  | 8,503                             | \$3,789,388                                      | 146.1   | 0.972   | \$3,683,047  | \$433   | Completion date is at end of remedial work.<br>Not clear how much idle rig time.  |
|                 |   |                                   |  |   |   |  |   |   |
| SSU3 1          | 1-Jul-88  | 7,000                             | \$3,575,000                                      | 89.7  | 1.583   | \$5,659,420  | \$808   | From GCS <sup>1</sup> submitted to CEC by Unocal<br>on 7 September 1993. Average of 2 producers.  |

# Hetch Hetchy/SFPUC Programmatic Renewable Energy Project

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**Project Team:** GeothermEx, Inc.

**Task:** 1.3.10 Final Project Report

**Subject:** D.1.3.10.3 Final Report

**Table 6a: Data for Statistical Correlation of Drilling Costs vs. Depth**

| <i>Well</i> | <i>Completion<br/>Date<br/>(estimated<br/>dates in<br/>italics)</i> | <i>Total<br/>Depth<br/>(feet)</i> | <i>Unescalated<br/>Total<br/>Cost<br/>(US\$)</i> | <i>Producer<br/>Price<br/>Index<br/>(PPI)</i> | <i>Escalation<br/>Factor to<br/>July 2003<br/>(PPI=142.0)</i> | <i>Total Cost<br/>Escalated<br/>to 2003<br/>(US\$)</i> | <i>Escalated<br/>Cost<br/>Per Foot<br/>(US\$)</i> | <i>Comments</i>   |
|-------------|---|-----------------------------------|--|---|---|--|---|---|
| Vulcan 1    | 1-Jul-85  | 4,000                             | \$1,772,486                                      | 100.0   | 1.420   | \$2,516,930  | \$629   | From GCS <sup>1</sup> submitted to CEC by Magma on 2 September 1993. Average of 7 producers.  |
| Hoch 1      | 1-Jul-87  | 5,000                             | \$3,078,000                                      | 87.6  | 1.621   | \$4,989,452  | \$998   | From GCS <sup>1</sup> submitted to CEC by Magma on 2 September 1993. Average of 7 producers.  |
| Elmore 1    | 1-Jul-87  | 6,000                             | \$2,858,556                                      | 87.6  | 1.621   | \$4,633,732  | \$772   | From GCS <sup>1</sup> submitted to CEC by Magma on 2 September 1993. Average of 8 producers.  |
| Leathers 1  | 1-Jul-88  | 7,500                             | \$2,970,302                                      | 89.7  | 1.583   | \$4,702,150  | \$627   | From GCS <sup>1</sup> submitted to CEC by Magma on 2 September 1993. Average of 8 producers.  |
| SSU3 2      | 1-Jul-88  | 7,000                             | \$1,516,667                                      | 89.7  | 1.583   | \$2,400,967  | \$343   | From GCS <sup>1</sup> submitted to CEC by Unocal on 7 September 1993. Average of 3 injectors. Depth assumed to be same as production wells. |
| Vulcan 2    | 1-Jul-85  | 4,000                             | \$1,423,800                                      | 100.0   | 1.420   | \$2,021,796  | \$505   | From GCS <sup>1</sup> submitted to CEC by Magma on 2 September 1993. Average of 5 injectors. Depth assumed to be same as production wells.  |
| Hoch 2      | 1-Jul-87  | 5,000                             | \$1,539,000                                      | 87.6  | 1.621   | \$2,494,726  | \$499   | From GCS <sup>1</sup> submitted to CEC by Magma on 2 September 1993. Average of 4 injectors. Depth assumed to be same as production wells.  |
| Elmore 2    | 1-Jul-87  | 6,000                             | \$1,767,108                                      | 87.6  | 1.621   | \$2,864,490  | \$477   | From GCS <sup>1</sup> submitted to CEC by Magma on 2 September 1993. Average of 4 injectors. Depth assumed to be same as production wells.  |

# Hetch Hetchy/SFPUC Programmatic Renewable Energy Project

**Project:** 1.3 New Geothermal Site Identification and Qualification

**Project Team:** GeothermEx, Inc.

**Task:** 1.3.10 Final Project Report

**Subject:** D.1.3.10.3 Final Report

**Table 6a: Data for Statistical Correlation of Drilling Costs vs. Depth**

| <i>Well</i> | <i>Completion<br/>Date<br/>(estimated<br/>dates in<br/>italics)</i> | <i>Total<br/>Depth<br/>(feet)</i> | <i>Unescalated<br/>Total<br/>Cost<br/>(US\$)</i> | <i>Producer<br/>Price<br/>Index<br/>(PPI)</i> | <i>Escalation<br/>Factor to<br/>July 2003<br/>(PPI=142.0)</i> | <i>Total Cost<br/>Escalated<br/>to 2003<br/>(US\$)</i> | <i>Escalated<br/>Cost<br/>Per Foot<br/>(US\$)</i> | <i>Comments</i>   |
|-------------|---|-----------------------------------|--|---|---|--|---|---|
| Leathers 2  | 1-Jul-88  | 7,500                             | \$2,506,193                                      | 89.7  | 1.583   | \$3,967,440  | \$529   | From GCS <sup>1</sup> submitted to CEC by Magma on 2 September 1993. Average of 4 injectors. Depth assumed to be same as production wells.  |
| HFC 1       | 1-Jul-84  | 6,000                             | \$1,904,762                                      | 100.0   | 1.420   | \$2,704,762  | \$451   | From GCS <sup>1</sup> submitted to CEC by HGC on 26 August 1993. Average of 11 producers and 10 injectors. Calculated as total field cost (including gathering system) divided by 21 wells. |
| SIGC 1      | 1-Jul-93  | 5,000                             | \$1,018,182                                      | 91.4  | 1.554   | \$1,581,858  | \$316   | From GCS <sup>1</sup> submitted to CEC by Ormat (Fall 1993). Average of 11 producers.   |
| SIGC 2      | 1-Jul-93  | 5,000                             | \$868,000  | 91.4  | 1.554   | \$1,348,534  | \$270   | From GCS <sup>1</sup> submitted to CEC by Ormat (Fall 1993). Average of 10 injectors. Depth assumed to be same as production wells.   |
| Ormesa I-1  | 1-Jul-86  | 5,000                             | \$852,632  | 93.0  | 1.527   | \$1,301,868  | \$260   | From GCS <sup>1</sup> submitted to CEC by Ormat (Fall 1993). Average of 19 producers.   |
| Ormesa I-2  | 1-Jul-86  | 5,000                             | \$553,846  | 93.0  | 1.527   | \$845,657  | \$169   | From GCS <sup>1</sup> submitted to CEC by Ormat (Fall 1993). Average of 13 injectors. Depth assumed to be same as production wells.   |
| Ormesa II-1 | 1-Jul-87  | 5,000                             | \$835,714  | 87.6  | 1.621   | \$1,354,696  | \$271   | From GCS <sup>1</sup> submitted to CEC by Ormat (Fall 1993). Average of 7 producers.  |
| Ormesa II-2 | 1-Jul-87  | 5,000                             | \$812,500  | 87.6  | 1.621   | \$1,317,066  | \$263   | From GCS <sup>1</sup> submitted to CEC by Ormat (Fall 1993). Average of 4 injectors. Depth assumed to be same as production wells.  |

# Hetch Hetchy/SFPUC Programmatic Renewable Energy Project

**Project:** 1.3 New Geothermal Site Identification and Qualification

**Project Team:** GeothermEx, Inc.

**Task:** 1.3.10 Final Project Report

**Subject:** D.1.3.10.3 Final Report

**Table 6a: Data for Statistical Correlation of Drilling Costs vs. Depth**

| <i>Well</i>    | <i>Completion<br/>Date<br/>(estimated<br/>dates in<br/>italics)</i> | <i>Total<br/>Depth<br/>(feet)</i> | <i>Unescalated<br/>Total<br/>Cost<br/>(US\$)</i> | <i>Producer<br/>Price<br/>Index<br/>(PPI)</i> | <i>Escalation<br/>Factor to<br/>July 2003<br/>(PPI=142.0)</i> | <i>Total Cost<br/>Escalated<br/>to 2003<br/>(US\$)</i> | <i>Escalated<br/>Cost<br/>Per Foot<br/>(US\$)</i> | <i>Comments</i>  |
|----------------|---|-----------------------------------|--|---|---|--|---|------------------|
| El Salvador 1  | 18-Mar-98   | 4,788                             | \$1,800,477                                      | 120.2   | 1.181   | \$2,127,019  | \$444   | Directional well |
| El Salvador 2  | 25-Aug-97   | 5,276                             | \$2,020,711                                      | 114.2   | 1.243   | \$2,512,618  | \$476   | Directional well |
| El Salvador 3  | 30-Sep-97   | 5,250                             | \$1,833,972                                      | 114.4   | 1.241   | \$2,276,434  | \$434   | Directional well |
| El Salvador 4  | 22-Sep-97   | 5,341                             | \$1,762,148                                      | 114.4   | 1.241   | \$2,187,282  | \$409   | Vertical well    |
| El Salvador 5  | 14-Dec-97   | 5,399                             | \$2,054,171                                      | 118.2   | 1.201   | \$2,467,786  | \$457   | Directional well |
| El Salvador 6  | 15-Jun-98   | 4,944                             | \$1,694,198                                      | 118.2   | 1.201   | \$2,035,331  | \$412   | Directional well |
| El Salvador 7  | 6-Sep-98  | 5,104                             | \$2,141,611                                      | 118.6   | 1.197   | \$2,564,155  | \$502   | Directional well |
| El Salvador 8  | 3-Jul-97  | 5,253                             | \$3,088,393                                      | 113.5   | 1.251   | \$3,863,893  | \$736   | Directional well |
| El Salvador 9  | 1-Jun-99  | 2,461                             | \$1,730,924                                      | 114.3   | 1.242   | \$2,150,404  | \$874   | Vertical well    |
| El Salvador 10 | 30-May-97   | 2,133                             | \$1,209,395                                      | 111.4   | 1.275   | \$1,541,599  | \$723   | Vertical well    |
| El Salvador 11 | 27-Feb-98   | 7,648                             | \$2,567,631                                      | 120.2   | 1.181   | \$3,033,308  | \$397   | Directional well |
| El Salvador 12 | 1-Aug-98  | 7,979                             | \$2,344,005                                      | 119.0   | 1.193   | \$2,797,048  | \$351   | Directional well |
| El Salvador 13 | 1-Jan-99  | 8,186                             | \$2,208,848                                      | 119.2   | 1.191   | \$2,631,346  | \$321   | Directional well |
| El Salvador 14 | 4-Dec-97  | 7,077                             | \$3,905,537                                      | 118.2   | 1.201   | \$4,691,931  | \$663   | Directional well |
| El Salvador 15 | 30-Mar-98   | 7,520                             | \$2,958,289                                      | 120.2   | 1.181   | \$3,494,817  | \$465   | Directional well |
| El Salvador 16 | 24-Aug-98   | 7,149                             | \$3,680,947                                      | 119.0   | 1.193   | \$4,392,391  | \$614   | Directional well |
| El Salvador 17 | 29-Aug-98   | 7,630                             | \$3,186,211                                      | 119.0   | 1.193   | \$3,802,033  | \$498   | Directional well |
| El Salvador 18 | 1-Jul-98  | 7,244                             | \$3,212,397                                      | 118.0   | 1.203   | \$3,865,766  | \$534   | Directional well |
| El Salvador 19 | 30-Mar-98   | 7,684                             | \$2,530,845                                      | 120.2   | 1.181   | \$2,989,850  | \$389   | Directional well |
| El Salvador 20 | 1-Jul-98  | 2,461                             | \$984,492  | 118.0   | 1.203   | \$1,184,728  | \$481   | Vertical well    |
| El Salvador 21 | 1-Jul-98  | 8,498                             | \$2,151,796                                      | 118.0   | 1.203   | \$2,589,450  | \$305   | Directional well |
| El Salvador 22 | 16-Oct-97   | 8,203                             | \$2,563,282                                      | 116.1   | 1.223   | \$3,135,108  | \$382   | Vertical well    |
| El Salvador 23 | 14-Jan-98   | 1,653                             | \$1,226,493                                      | 119.0   | 1.193   | \$1,463,547  | \$885   | Directional well |

## Hetch Hetchy/SFPUC Programmatic Renewable Energy Project

**Project:** 1.3 New Geothermal Site Identification and Qualification

**Project Team:** GeothermEx, Inc.

**Task:** 1.3.10 Final Project Report

**Subject:** D.1.3.10.3 Final Report

**Table 6a: Data for Statistical Correlation of Drilling Costs vs. Depth**

| <i>Well</i>    | <i>Completion<br/>Date<br/>(estimated<br/>dates in<br/>italics)</i> | <i>Total<br/>Depth<br/>(feet)</i> | <i>Unescalated<br/>Total<br/>Cost<br/>(US\$)</i> | <i>Producer<br/>Price<br/>Index<br/>(PPI)</i> | <i>Escalation<br/>Factor to<br/>July 2003<br/>(PPI=142.0)</i> | <i>Total Cost<br/>Escalated<br/>to 2003<br/>(US\$)</i> | <i>Escalated<br/>Cost<br/>Per Foot<br/>(US\$)</i> | <i>Comments</i>                                 |
|----------------|---|-----------------------------------|--|---|---|--|---|---|
| El Salvador 24 | 11-Feb-98   | 2,015                             | \$844,752  | 120.2   | 1.181   | \$997,960  | \$495   | Directional well                                |
| El Salvador 25 | 29-Mar-98   | 2,133                             | \$1,108,839                                      | 120.2   | 1.181   | \$1,309,943  | \$614   | Directional well                                |
| El Salvador 26 | 27-Nov-97   | 6,709                             | \$962,439  | 117.8   | 1.205   | \$1,160,155  | \$173   | Vertical well                                   |
| El Salvador 27 | 4-Dec-98  | 2,406                             | \$996,157  | 119.7   | 1.186   | \$1,181,740  | \$491   | Vertical well                                   |
| El Salvador 28 | 1-Jan-99  | 7,966                             | \$2,574,545                                      | 119.2   | 1.191   | \$3,066,991  | \$385   | Directional well                                |
|                |   |                                   |  |   |   |  |   |   |
| Azores 1       | 1-Jul-00  | 3,724                             | \$1,890,000                                      | 125.2   | 1.134   | \$2,143,610  | \$576   |   |
|                |   |                                   |  |   |   |  |   |   |
| Guatemala 1    | 3-Aug-99  | 655                               | \$239,911  | 114.5   | 1.240   | \$297,532  | \$454   | Includes mobilization (\$17,500) but no de-mob. |
| Guatemala 2    | 7-Jul-99  | 1,996                             | \$454,222  | 114.3   | 1.242   | \$564,300  | \$283   | Includes mobilization (\$17,500) but no de-mob. |

1. GCS = Geothermal Cost Survey conducted in 1993.

# Hetch Hetchy/SFPUC Programmatic Renewable Energy Project

**Project:** 1.3 New Geothermal Site Identification and Qualification

**Project Team:** GeothermEx, Inc.

**Task:** 1.3.10 Final Project Report

**Subject:** D.1.3.10.3 Final Report

**Table 6b. Data for Statistical Correlation of Well Productivity vs. Temperature**

| <i>Project ID</i> | <i>Field</i>                | <i>Project</i>             | <i>Plant Capacity<br/>(MW gross)</i> | <i>Plant Technology</i> | <i>Well Type<sup>1</sup></i> | <i>Number of Active Producers</i> | <i>MW gross per Active Well</i> | <i>Permeable Zone Average Temperature<sup>2</sup><br/>(°F)</i> |
|-------------------|-----------------------------|----------------------------|--------------------------------------|-------------------------|------------------------------|-----------------------------------|---------------------------------|--|
| BEO00             | Beowawe                     |                            | 16.7                                 | Dual Flash              | P                            | 3                                 | 5.6                             | 420  |
| BRA00             | Brady's Hot Springs         |                            | 26                                   |                         | S, P                         | 11                                | 2.4                             | 365  |
| COS00             | Coso                        | Field-wide Summary         | 300                                  | Dual Flash              | S                            | 93                                | 3.2                             | 521  |
| DES00             | Desert Peak                 |                            | 11                                   | Dual Flash              | S                            | 2                                 | 5.5                             | 412.5  |
| DIX00             | Dixie Valley                | Caithness Dixie Valley     | 62                                   | Single Flash            | S                            | 7                                 | 8.9                             | 453  |
| EMP00             | Empire (San Emidio)         | Field-wide summary         | 4.8                                  | Binary                  | P                            | 3                                 | 1.6                             | 305.5  |
| HON01             | Honey Lake                  | Amedee                     | 1.75                                 | Binary-Water Cooled     | P                            | 2                                 | 0.9                             | 224.5  |
| HON02             | Honey Lake                  | Wendel/Wineagle            | 0.7                                  | Binary-Water Cooled     | P                            | 1                                 | 0.7                             | 230  |
| HON03             | Honey Lake                  | Wendel/Honey Lake Power    | 2.5                                  | Hybrid                  | P                            | 1                                 | 2.5                             | 247  |
| LAK00             | Lake City / Surprise Valley | Lake City                  | 2.5                                  |                         | S                            | 1                                 | 2.5                             | 332.5  |
| LVC00             | Long Valley - Casa Diablo   | MP Field Summary           | 40                                   | Binary                  | P                            | 8                                 | 5.0                             | 337.5  |
| SOD00             | Soda Lake                   | Soda Lake No.1/No.2        | 26.1                                 | Binary-Air Cooled       | P                            | 5                                 | 5.2                             | 367  |
| STE01             | Steamboat Hot Sprs          | Lower SB: Steamboat I-1A   | 9.2                                  | Binary-Air Cooled       | P                            | 3                                 | 3.1                             | 335  |
| STE02             | Steamboat Hot Sprs          | Lower SB: Steamboat II-III | 36.2                                 | Binary-Air Cooled       | P                            | 8                                 | 4.5                             | 330  |
| STE05             | Steamboat Hot Sprs          | Upper SB: Yankee-Caithness | 14.44                                | Dual Flash              | S                            | 3                                 | 4.8                             | 457  |
| STI00             | Stillwater                  | Stillwater Geothermal 1    | 19                                   | Binary-Air Cooled       | S, P                         | 4                                 | 4.8                             | 332.5  |
| WAB00             | Wabuska                     |                            | 1.45                                 | Binary                  | P                            | 1                                 | 1.5                             | 223.5  |

Notes:

(1) S = self-flowing, P = pumped.

(2) The permeable zone average temperature is the average of the Min and Max values specifically for the permeable zone, as listed in the Data Summary Sheet for each field. This is typically higher than the most-likely value of the average reservoir temperature used in the Monte-Carlo heat-in-place calculation.

**Hetch Hetchy/SFPUC Programmatic Renewable Energy Project**  
**Project: 1.3 New Geothermal Site Identification and Qualification**  
**Project Team: GeothermEx, Inc.**  
**Task: 1.3.10 Final Project Report**  
**Subject: D.1.3.10.3 Final Report**

(1)

***Table 7: Details of Exploration Programs***

***Project: AUR00 Aurora***

| <b><i>Method</i></b>   | <b><i>Unit</i></b> | <b><i># Units</i></b> | <b><i>Cost / unit</i></b> | <b><i>Cost Adj.Fact.</i></b> | <b><i>Comment</i></b>   | <b><i>Cost</i></b>      |
|--|--------------------|-----------------------|---------------------------|------------------------------|---|-------------------------|
| Drilling: ID slim hole(s)                                      | foot               | 4000                  | \$140.00                  | 1.0                          | Two holes to 2000 ft each   | \$560,000               |
| Drilling: ID Slim hole(s): roads and pads                      | well               | 2                     | \$50,000.00               | 0.5                          |   | \$50,000                |
| Drilling: ID Slim hole(s): temperature logs                    | well               | 2                     | \$5,000.00                | 1.0                          |   | \$10,000                |
| Drilling: TG hole(s)   | foot               | 2500                  | \$15.00                   | 1.0                          | Five holes to 500 ft each, to better define the heat anomaly between the Aurora hole and the hot area at Borealis mine. | \$37,500                |
| Geology: field mapping   | project            | 1                     | \$20,000.00               | 1.0                          | May be less if Phillips data can be obtained.   | \$20,000                |
| Geophysical survey: gravity                                    | project            | 1                     | \$25,000.00               | 1.0                          | May be less if Phillips did survey and data can be obtained.  | \$25,000                |
| Geophysical survey: ground magnetics                           | project            | 1                     | \$12,500.00               | 1.0                          | May be less if Phillips did survey and data can be obtained.  | \$12,500                |
| Reporting - Documentation and Administration (20% of subtotal) |                    |                       |                           |                              |   | \$143,000               |
| <b><i>Total for Project</i></b>                                |                    |                       |                           |                              |   | <b><i>\$858,000</i></b> |

***Project: BAL00 Baltazor***

| <b><i>Method</i></b>   | <b><i>Unit</i></b> | <b><i># Units</i></b> | <b><i>Cost / unit</i></b> | <b><i>Cost Adj.Fact.</i></b> | <b><i>Comment</i></b>   | <b><i>Cost</i></b> |
|--|--------------------|-----------------------|---------------------------|------------------------------|---|--------------------|
|  |                    |                       |                           |                              | Considerable information appears to exist in the public domain.<br>Additional exploration probably not warranted. |                    |
| Reporting - Documentation and Administration (20% of subtotal) |                    |                       |                           |                              |   |                    |
| <b><i>Total for Project</i></b>                                |                    |                       |                           |                              |   |                    |

***Project: BEO00 Beowawe***

| <b><i>Method</i></b>   | <b><i>Unit</i></b> | <b><i># Units</i></b> | <b><i>Cost / unit</i></b> | <b><i>Cost Adj.Fact.</i></b> | <b><i>Comment</i></b>  | <b><i>Cost</i></b> |
|--|--------------------|-----------------------|---------------------------|------------------------------|--|--------------------|
|  |                    |                       |                           |                              | A well-known area. Significant additional exploration probably not needed. |                    |
| Reporting - Documentation and Administration (20% of subtotal) |                    |                       |                           |                              |  |                    |
| <b><i>Total for Project</i></b>                                |                    |                       |                           |                              |  |                    |

**Project: BLU00 Blue Mountain**

| <b>Method</b>  | <b>Unit</b> | <b># Units</b> | <b>Cost / unit</b> | <b>Cost Adj.Fact.</b> | <b>Comment</b>   | <b>Cost</b>     |
|--|-------------|----------------|--------------------|-----------------------|--|-----------------|
| Geochemistry surveys   | project     | 1              | \$30,000.00        | 0.5                   |  | \$15,000        |
| Geophysical survey: gravity                                    | project     | 1              | \$25,000.00        | 1.0                   | Extensive exploration has already been done, although the documentation obtained does not mention detailed gravimetry or detailed fluids chemistry surveys (water samples from boreholes), and does not describe the chemical data that may have been obtained from hole Deep Blue No.1. Accordingly, these two kinds of survey are listed here. | \$25,000        |
| Reporting - Documentation and Administration (20% of subtotal) |             |                |                    |                       |  | \$8,000         |
| <b>Total for Project</b>                                       |             |                |                    |                       |  | <b>\$48,000</b> |

**Project: BRA00 Brady's Hot Springs**

| <b>Method</b> | <b>Unit</b> | <b># Units</b> | <b>Cost / unit</b> | <b>Cost Adj.Fact.</b> | <b>Comment</b>  | <b>Cost</b> |
|---------------|-------------|----------------|--------------------|-----------------------|---|-------------|
|               |             |                |                    |                       | It is assumed that any additional exploration of the Brady's area will consist of the integration of existing data, and deep drilling that is estimated under confirmation costs. |             |

Reporting - Documentation and Administration (20% of subtotal)

**Total for Project****Project: BRW01 Brawley - Brawley (North Brawley)**

| <b>Method</b> | <b>Unit</b> | <b># Units</b> | <b>Cost / unit</b> | <b>Cost Adj.Fact.</b> | <b>Comment</b>                                      | <b>Cost</b> |
|---------------|-------------|----------------|--------------------|-----------------------|---|-------------|
|               |             |                |                    | 1.0                   | It is assumed that no further exploration is needed |             |

Reporting - Documentation and Administration (20% of subtotal)

**Total for Project****Project: BRW02 Brawley - East Brawley**

| <b>Method</b>        | <b>Unit</b> | <b># Units</b> | <b>Cost / unit</b> | <b>Cost Adj.Fact.</b> | <b>Comment</b>   | <b>Cost</b> |
|----------------------|-------------|----------------|--------------------|-----------------------|--|-------------|
| Drilling: TG hole(s) | foot        | 5000           | \$15.00            | 1.0                   | Drill 10 holes to 500 ft each (or a larger number to shallower depth), to better define the temperature anomaly. | \$75,000    |

Reporting - Documentation and Administration (20% of subtotal)

**Total for Project****Project: BRW03 Brawley - South Brawley (Mesquite field)**

| <b>Method</b>        | <b>Unit</b> | <b># Units</b> | <b>Cost / unit</b> | <b>Cost Adj.Fact.</b> | <b>Comment</b>  | <b>Cost</b> |
|----------------------|-------------|----------------|--------------------|-----------------------|---|-------------|
| Drilling: TG hole(s) | foot        | 5000           | \$15.00            | 1.0                   | Drill 10 holes to 500 ft, to better define the temperature anomaly. | \$75,000    |

|  |                 |
|--|-----------------|
| Reporting - Documentation and Administration (20% of subtotal) | \$15,000        |
| <b>Total for Project</b>                                       | <b>\$90,000</b> |

**Project: CAL00 Calistoga**

| <b>Method</b> | <b>Unit</b> | <b># Units</b> | <b>Cost / unit</b> | <b>Cost Adj.Fact.</b> | <b>Comment</b>  | <b>Cost</b> |
|---------------|-------------|----------------|--------------------|-----------------------|---|-------------|
|               |             |                |                    |                       | It is assumed that sufficient exploration has been done to enable a deep, full-diameter hole to be sited. |             |

|  |  |
|--|--|
| Reporting - Documentation and Administration (20% of subtotal) |  |
| <b>Total for Project</b>                                       |  |

**Project: COL00 Colado**

| <b>Method</b>                               | <b>Unit</b> | <b># Units</b> | <b>Cost / unit</b> | <b>Cost Adj.Fact.</b> | <b>Comment</b>  | <b>Cost</b> |
|---|-------------|----------------|--------------------|-----------------------|---|-------------|
| Drilling: ID slim hole(s)                   | foot        | 4000           | \$140.00           | 1.0                   | Two holes, each to c.2000 ft, to test the area S of Woolsey.  | \$560,000   |
| Drilling: ID Slim hole(s): roads and pads   | well        | 2              | \$50,000.00        | 1.0                   |   | \$100,000   |
| Drilling: ID Slim hole(s): temperature logs | well        | 1              | \$5,000.00         | 1.0                   |   | \$5,000     |
| Geophysical survey: gravity                 | project     | 1              | \$25,000.00        | 1.0                   | The Getty hole was probably too far to the south. An exploration program that targets the area of hot wells S of Woolsey is envisioned. | \$25,000    |
| Well Test: ID slim hole, 3-10 days          | well        | 2              | \$40,000.00        | 1.0                   |   | \$80,000    |

|  |                  |
|--|------------------|
| Reporting - Documentation and Administration (20% of subtotal) | \$154,000        |
| <b>Total for Project</b>                                       | <b>\$924,000</b> |

**Project: COS00 Coso - Field-wide Summary**

| <b>Method</b> | <b>Unit</b> | <b># Units</b> | <b>Cost / unit</b> | <b>Cost Adj.Fact.</b> | <b>Comment</b>  | <b>Cost</b> |
|---------------|-------------|----------------|--------------------|-----------------------|---|-------------|
|               |             |                |                    |                       | It is assumed that any "exploration" costs for expansion to the Mlk (Modal) Estimated Capacity would be a small fraction of confirmation costs. However, if the expansion includes a significant step-out (e.g. to the Northeast Frontier, project COS04), then part of this "confirmation" expense may be considered to be "exploration" |             |

|  |  |
|--|--|
| Reporting - Documentation and Administration (20% of subtotal) |  |
| <b>Total for Project</b>                                       |  |

**Project: DES00 Desert Peak**

| <b>Method</b> | <b>Unit</b> | <b># Units</b> | <b>Cost / unit</b> | <b>Cost Adj.Fact.</b> | <b>Comment</b>  | <b>Cost</b> |
|---------------|-------------|----------------|--------------------|-----------------------|---|-------------|
|               |             |                |                    |                       | The area has been extensively explored already. No new activity foreseen, other than deep drilling and testing. |             |

Reporting - Documentation and Administration (20% of subtotal)

**Total for Project**

**Project: DIX00 Dixie Valley - Caithness Dixie Valley**

| <b>Method</b> | <b>Unit</b> | <b># Units</b> | <b>Cost / unit</b> | <b>Cost Adj.Fact.</b> | <b>Comment</b>   | <b>Cost</b> |
|---------------|-------------|----------------|--------------------|-----------------------|--|-------------|
|               |             |                |                    |                       | The area has already been extensively explored. No new activities foreseen other than deep drilling. |             |

Reporting - Documentation and Administration (20% of subtotal)

**Total for Project**

**Project: DIX01 Dixie Valley - Dixie Valley Power Partners (DVPP)**

| <b>Method</b> | <b>Unit</b> | <b># Units</b> | <b>Cost / unit</b> | <b>Cost Adj.Fact.</b> | <b>Comment</b>   | <b>Cost</b> |
|---------------|-------------|----------------|--------------------|-----------------------|--|-------------|
| Other         | project     | 1              | \$10,000.00        | 5.0                   | Review of existing data and information to assist the siting of deep holes drilled for confirmation. | \$50,000    |

Reporting - Documentation and Administration (20% of subtotal)

**Total for Project**

**Project: DOU00 Double - Black Rk Hot Springs**

| <b>Method</b>                               | <b>Unit</b> | <b># Units</b> | <b>Cost / unit</b> | <b>Cost Adj.Fact.</b> | <b>Comment</b>  | <b>Cost</b> |
|---|-------------|----------------|--------------------|-----------------------|---|-------------|
| Drilling: ID slim hole(s)                   | foot        | 16000          | \$140.00           | 1.0                   | Two holes to 2000 ft each, at each of 4 hot spring areas along the lineament. | \$2,240,000 |
| Drilling: ID Slim hole(s): roads and pads   | well        | 8              | \$50,000.00        | 1.0                   |   | \$400,000   |
| Drilling: ID Slim hole(s): temperature logs | well        | 8              | \$5,000.00         | 1.0                   |   | \$40,000    |
| Drilling: TG hole(s)                        | foot        | 20000          | \$15.00            | 1.0                   | Ten holes to 500 ft each, at each of 4 hot spring areas along the lineament.  | \$300,000   |
| Geophysical survey: gravity                 | project     | 4              | \$25,000.00        | 0.8                   | Gravity surveys around and between each of 4 hot spring areas.                | \$80,000    |
| Geophysical survey: ground magnetics        | project     | 4              | \$12,500.00        | 0.8                   | Surveys around and between each of 4 hot spring areas.                        | \$40,000    |
| Geophysical survey: MT or DC resistivity    | project     | 2              | \$200,000.00       | 1.0                   | Surveys in two areas.   | \$400,000   |
| Well Test: ID slim hole, 3-10 days          | well        | 4              | \$40,000.00        | 1.0                   |   | \$160,000   |

Reporting - Documentation and Administration (20% of subtotal)

**Total for Project**

**Project: DUN00 Dunes**

| <b>Method</b> | <b>Unit</b> | <b># Units</b> | <b>Cost / unit</b> | <b>Cost Adj.Fact.</b> | <b>Comment</b> | <b>Cost</b> |
|---------------|-------------|----------------|--------------------|-----------------------|----------------|-------------|
|---------------|-------------|----------------|--------------------|-----------------------|----------------|-------------|

|  |         |      |             |     |   |                  |
|--|---------|------|-------------|-----|---|------------------|
| Drilling: ID slim hole(s)                                      | foot    | 4000 | \$140.00    | 1.0 | Two holes each to 2000 ft. One would be sited at location of hole UCR 115 (Figure DUN00-2), the second to the west, probably between there and hole DWR No.1. | \$560,000        |
| Drilling: ID Slim hole(s): roads and pads                      | well    | 2    | \$50,000.00 | 1.0 |   | \$100,000        |
| Drilling: ID Slim hole(s): temperature logs                    | well    | 2    | \$5,000.00  | 1.0 |   | \$10,000         |
| Geophysical survey: gravity                                    | project | 1    | \$25,000.00 | 1.0 |   | \$25,000         |
| Reporting - Documentation and Administration (20% of subtotal) |         |      |             |     |   | \$139,000        |
| <b>Total for Project</b>                                       |         |      |             |     |   | <b>\$834,000</b> |

**Project: EAS00 East Mesa - Field-wide summary**

| <b>Method</b> | <b>Unit</b> | <b># Units</b> | <b>Cost / unit</b> | <b>Cost Adj.Fact.</b> | <b>Comment</b> | <b>Cost</b> |
|---------------|-------------|----------------|--------------------|-----------------------|----------------|-------------|
|---------------|-------------|----------------|--------------------|-----------------------|----------------|-------------|

Reporting - Documentation and Administration (20% of subtotal)

**Total for Project**

**Project: EMI00 Emigrant (Fish Lake V.)**

| <b>Method</b> | <b>Unit</b> | <b># Units</b> | <b>Cost / unit</b> | <b>Cost Adj.Fact.</b> | <b>Comment</b>   | <b>Cost</b> |
|---------------|-------------|----------------|--------------------|-----------------------|--|-------------|
| Other         | project     | 1              | \$10,000.00        | 4.0                   | Cost of compiling and interpreting existing exploration data (much of it in private hands) to enable siting a deep hole. | \$40,000    |

Reporting - Documentation and Administration (20% of subtotal)

**Total for Project**

**Project: EMP00 Empire (San Emidio) - Field-wide summary**

| <b>Method</b> | <b>Unit</b> | <b># Units</b> | <b>Cost / unit</b> | <b>Cost Adj.Fact.</b> | <b>Comment</b> | <b>Cost</b> |
|---------------|-------------|----------------|--------------------|-----------------------|----------------|-------------|
|---------------|-------------|----------------|--------------------|-----------------------|----------------|-------------|

Reporting - Documentation and Administration (20% of subtotal)

**Total for Project**

**Project: FAL00 Fallon / Carson Lake - Carson Lake anomaly**

| <b>Method</b> | <b>Unit</b> | <b># Units</b> | <b>Cost / unit</b> | <b>Cost Adj.Fact.</b> | <b>Comment</b>  | <b>Cost</b> |
|---------------|-------------|----------------|--------------------|-----------------------|---|-------------|
| Other         | project     | 1              | \$10,000.00        | 4.0                   | Integration of existing data to allow siting the first deep hole. It is assumed that the most important data and information is in the public domain, or can be obtained from private parties at a reasonable cost. | \$40,000    |

Reporting - Documentation and Administration (20% of subtotal)

**Total for Project**

|  |             |   |                    |                       |  |                  |  |
|--|-------------|---|--------------------|-----------------------|--|------------------|--|
| <b>Project: FIS00</b>  |             | <b>Fish Lake (Valley)</b>                                       |                    |                       |  |                  |  |
| <b>Method</b>  | <b>Unit</b> | <b># Units</b>  | <b>Cost / unit</b> | <b>Cost Adj.Fact.</b> | <b>Comment</b>   | <b>Cost</b>      |  |
| Other  | project     | 1   | \$10,000.00        | 6.0                   | Cost of integrating the large body of existing data to site further deep drilling.   | \$60,000         |  |
| Reporting - Documentation and Administration (20% of subtotal) |             |   |                    |                       |  | \$12,000         |  |
| <b>Total for Project</b>                                       |             |   |                    |                       |  | <b>\$72,000</b>  |  |
| <b>Project: FLY00</b>  |             | <b>Fly Ranch/Granite Ranch - Ward's (Fly/Hualapi Flat) H.S.</b> |                    |                       |  |                  |  |
| <b>Method</b>  | <b>Unit</b> | <b># Units</b>  | <b>Cost / unit</b> | <b>Cost Adj.Fact.</b> | <b>Comment</b>   | <b>Cost</b>      |  |
|  |             |   |                    |                       | No exploration program is estimated, because deep drilling has discovered a temperature of only 211°F at 5,000 ft depth. Further exploration and deep drilling are relatively unlikely to attract commercial interest. |                  |  |
| Reporting - Documentation and Administration (20% of subtotal) |             |   |                    |                       |  |                  |  |
| <b>Total for Project</b>                                       |             |   |                    |                       |  |                  |  |
| <b>Project: FLY01</b>  |             | <b>Fly Ranch/Granite Ranch - Granite Ranch</b>                  |                    |                       |  |                  |  |
| <b>Method</b>  | <b>Unit</b> | <b># Units</b>  | <b>Cost / unit</b> | <b>Cost Adj.Fact.</b> | <b>Comment</b>   | <b>Cost</b>      |  |
| Drilling: ID slim hole(s)                                      | foot        | 400   | \$140.00           | 0.5                   | Drilled at the ranch location to intercept the 220°F permeable zone previously encountered and obtain fluids samples for chemical  | \$28,000         |  |
| Drilling: ID slim hole(s)                                      | foot        | 2000  | \$140.00           | 1.0                   | Two holes to 1000 ft each, sited and drilled after all other exploration studies.  | \$280,000        |  |
| Drilling: ID Slim hole(s): roads and pads                      | well        | 2   | \$50,000.00        | 1.0                   |  | \$100,000        |  |
| Drilling: ID Slim hole(s): temperature logs                    | well        | 2   | \$5,000.00         | 1.0                   |  | \$10,000         |  |
| Drilling: TG hole(s)   | foot        | 3000  | \$15.00            | 1.0                   | Six holes to 500 ft each, to define the anomaly.   | \$45,000         |  |
| Geophysical survey: gravity                                    | project     | 1   | \$25,000.00        | 1.0                   |  | \$25,000         |  |
| Geophysical survey: ground magnetics                           | project     | 1   | \$12,500.00        | 1.0                   |  | \$12,500         |  |
| Reporting - Documentation and Administration (20% of subtotal) |             |   |                    |                       |  | \$100,100        |  |
| <b>Total for Project</b>                                       |             |   |                    |                       |  | <b>\$600,600</b> |  |
| <b>Project: GER00</b>  |             | <b>Gerlach - (Great Boiling Spring)</b>                         |                    |                       |  |                  |  |
| <b>Method</b>  | <b>Unit</b> | <b># Units</b>  | <b>Cost / unit</b> | <b>Cost Adj.Fact.</b> | <b>Comment</b>   | <b>Cost</b>      |  |

|       |         |   |             |     |   |          |
|-------|---------|---|-------------|-----|---|----------|
| Other | project | 1 | \$10,000.00 | 3.0 | This area has already been extensively explored. The results of several holes drilled to c.3,000 ft during the early-mid 1990s are not available. It is assumed that these data can be obtained, and deep confirmation wells sited on the basis of the information obtained from them, once this has been integrated into all other information from the area. The cost listed represents studies to perform this data integration and well siting. | \$30,000 |
|-------|---------|---|-------------|-----|---|----------|

Reporting - Documentation and Administration (20% of subtotal) \$6,000

**Total for Project** \$36,000

**Project: GEY00 Geysers - Field-wide Summary**

| Method | Unit | # Units | Cost / unit | Cost Adj.Fact. | Comment | Cost |
|--------|------|---------|-------------|----------------|---------|------|
|--------|------|---------|-------------|----------------|---------|------|

Reporting - Documentation and Administration (20% of subtotal)

**Total for Project**

**Project: GLA00 Glamis**

| Method                                      | Unit    | # Units | Cost / unit | Cost Adj.Fact. | Comment                     | Cost      |
|---|---------|---------|-------------|----------------|-----------------------------|-----------|
| Drilling: ID slim hole(s)                   | foot    | 4000    | \$140.00    | 1.0            | Two holes each to 2,000 ft  | \$560,000 |
| Drilling: ID Slim hole(s): roads and pads   | well    | 2       | \$50,000.00 | 1.0            |                             | \$100,000 |
| Drilling: ID Slim hole(s): temperature logs | well    | 2       | \$5,000.00  | 1.0            |                             | \$10,000  |
| Drilling: TG hole(s)                        | foot    | 4000    | \$15.00     | 1.0            | Eight holes each to 500 ft. | \$60,000  |
| Geophysical survey: gravity                 | project | 1       | \$25,000.00 | 1.0            |                             | \$25,000  |

Reporting - Documentation and Administration (20% of subtotal) \$151,000

**Total for Project** \$906,000

**Project: HAW00 Hawthorne**

| Method | Unit    | # Units | Cost / unit | Cost Adj.Fact. | Comment   | Cost     |
|--------|---------|---------|-------------|----------------|---|----------|
| Other  | project | 1       | \$10,000.00 | 3.0            | It is assumed that the ID Slim hole drilling planned for 2003 is taking place or will take place, and that with that drilling there will be sufficient information for siting confirmation holes. The cost listed is to cover integration of all data and a selection of sites. | \$30,000 |

Reporting - Documentation and Administration (20% of subtotal) \$6,000

**Total for Project** \$36,000

**Project: HAZ00 Hazen (Black Butte) - (Patua Hot Springs)**

| Method | Unit | # Units | Cost / unit | Cost Adj.Fact. | Comment | Cost |
|--------|------|---------|-------------|----------------|---------|------|
|--------|------|---------|-------------|----------------|---------|------|

|  |         |      |              |     |  |                    |
|--|---------|------|--------------|-----|--|--------------------|
| Drilling: ID slim hole(s)                                      | foot    | 4000 | \$140.00     | 0.8 | Two holes to 2000 ft each. Cost factor is adjusted for the possibility of relatively easy drilling in sedimentary rocks (the Magma/Dow hole drilled to nearly 4000 ft at a location 1.5 miles to the SW encountered only sediments). It is assumed that these holes will not reach reservoir depth, so a testing cost is not listed. | \$448,000          |
| Drilling: ID Slim hole(s): roads and pads                      | well    | 2    | \$50,000.00  | 0.8 | For two holes, cost factor adjusted for flat terrain, possibility of relatively easy access.   | \$80,000           |
| Drilling: ID Slim hole(s): temperature logs                    | well    | 2    | \$5,000.00   | 1.0 |  | \$10,000           |
| Drilling: TG hole(s)   | foot    | 4000 | \$15.00      | 1.0 | To define the anomaly. Assumes 8 holes to 500 ft each.   | \$60,000           |
| Geophysical survey: gravity                                    | project | 1    | \$25,000.00  | 1.0 |  | \$25,000           |
| Geophysical survey: ground magnetics                           | project | 1    | \$12,500.00  | 1.0 |  | \$12,500           |
| Geophysical survey: MT or DC resistivity                       | project | 1    | \$200,000.00 | 1.0 |  | \$200,000          |
| Reporting - Documentation and Administration (20% of subtotal) |         |      |              |     |  | \$167,100          |
| <b>Total for Project</b>                                       |         |      |              |     |  | <b>\$1,002,600</b> |

**Project: HEB00 Heber - Field-wide Summary**

| <b>Method</b>  | <b>Unit</b> | <b># Units</b> | <b>Cost / unit</b> | <b>Cost Adj.Fact.</b> | <b>Comment</b> | <b>Cost</b> |
|--|-------------|----------------|--------------------|-----------------------|----------------|-------------|
| Additional exploration is assumed to be unnecessary. |             |                |                    |                       |                |             |

Reporting - Documentation and Administration (20% of subtotal)

**Total for Project**

**Project: HON00 Honey Lake - Area-wide Summary**

| <b>Method</b>  | <b>Unit</b> | <b># Units</b> | <b>Cost / unit</b> | <b>Cost Adj.Fact.</b> | <b>Comment</b> | <b>Cost</b> |
|--|-------------|----------------|--------------------|-----------------------|----------------|-------------|
| The area has been extensively explored. It is relatively unlikely that additional exploration will assist in the finding of deep permeability. Drilling is required. |             |                |                    |                       |                |             |

Reporting - Documentation and Administration (20% of subtotal)

**Total for Project**

**Project: HYD00 Hyder Hot Springs**

| <b>Method</b>                               | <b>Unit</b> | <b># Units</b> | <b>Cost / unit</b> | <b>Cost Adj.Fact.</b> | <b>Comment</b>  | <b>Cost</b> |
|---|-------------|----------------|--------------------|-----------------------|---|-------------|
| Drilling: ID slim hole(s)                   | foot        | 4000           | \$140.00           | 1.0                   | Two holes to 2000 ft each.                            | \$560,000   |
| Drilling: ID Slim hole(s): roads and pads   | well        | 1              | \$50,000.00        | 0.8                   | Relatively flat terrain, easy access possible.        | \$40,000    |
| Drilling: ID Slim hole(s): temperature logs | well        | 1              | \$5,000.00         | 1.0                   |   | \$5,000     |
| Drilling: TG hole(s)                        | foot        | 4000           | \$15.00            | 1.0                   | Eight holes to 500 ft., to better define the anomaly. | \$60,000    |
| Geophysical survey: gravity                 | project     | 1              | \$25,000.00        | 1.0                   |   | \$25,000    |
| Geophysical survey: ground magnetics        | project     | 1              | \$12,500.00        | 1.0                   |   | \$12,500    |

|  |                  |
|--|------------------|
| Reporting - Documentation and Administration (20% of subtotal) | \$140,500        |
| <b>Total for Project</b>                                       | <b>\$843,000</b> |

**Project: KYL00 Kyle Hot Springs (Granite Mtn.) - (Buena Vista Valley)**

| <b>Method</b>                               | <b>Unit</b> | <b># Units</b> | <b>Cost / unit</b> | <b>Cost Adj.Fact.</b> | <b>Comment</b>  | <b>Cost</b> |
|---|-------------|----------------|--------------------|-----------------------|---|-------------|
| Drilling: ID slim hole(s)                   | foot        | 4000           | \$140.00           | 1.0                   | Two holes to 2000 ft each. May be reduced to one hole if data are available from the oil and gas wells (Figure KYL00-1) | \$560,000   |
| Drilling: ID Slim hole(s): roads and pads   | well        | 1              | \$50,000.00        | 0.8                   |   | \$40,000    |
| Drilling: ID Slim hole(s): temperature logs | well        | 5              | \$5,000.00         | 1.0                   | Allows logging of oil and gas wells (availability not confirmed)  | \$25,000    |
| Drilling: TG hole(s)                        | foot        | 4000           | \$15.00            | 1.0                   | Eight holes each to 500 ft, to define the anomaly in the area of the hot springs.                                       | \$60,000    |

|  |                  |
|--|------------------|
| Reporting - Documentation and Administration (20% of subtotal) | \$137,000        |
| <b>Total for Project</b>                                       | <b>\$822,000</b> |

**Project: LAK00 Lake City / Surprise Valley - Lake City**

| <b>Method</b> | <b>Unit</b> | <b># Units</b> | <b>Cost / unit</b> | <b>Cost Adj.Fact.</b> | <b>Comment</b>  | <b>Cost</b> |
|---------------|-------------|----------------|--------------------|-----------------------|---|-------------|
|               |             |                |                    |                       | Since there is already one (apparently) successful confirmation hole, no additional exploration is envisioned. However, some additional studies may be warranted if not already done. These include gravimetry and a complete integration of the existing data. |             |

|  |  |
|--|--|
| Reporting - Documentation and Administration (20% of subtotal) |  |
| <b>Total for Project</b>                                       |  |

**Project: LEA00 Leach Hot Springs - Grass Valley**

| <b>Method</b>                               | <b>Unit</b> | <b># Units</b> | <b>Cost / unit</b> | <b>Cost Adj.Fact.</b> | <b>Comment</b>  | <b>Cost</b> |
|---|-------------|----------------|--------------------|-----------------------|---|-------------|
| Drilling: ID slim hole(s)                   | foot        | 2000           | \$140.00           | 1.0                   | The area has been very extensively explored, with much information in the public domain, but there is relatively little information from the area E of the hot springs. A small amount of drilling in the E area suggests elevated temperatures, and the possibility of an anomaly in the foot wall of the W-dipping fault (system) that probably feeds the hot springs. This cost represents drilling a hole to 2000 ft at a location about 0.5-0.7 miles E of the hot springs, in the middle of | \$280,000   |
| Drilling: ID Slim hole(s): roads and pads   | well        | 1              | \$50,000.00        | 1.0                   |   | \$50,000    |
| Drilling: ID Slim hole(s): temperature logs | well        | 1              | \$5,000.00         | 1.0                   |   | \$5,000     |

|  |                  |
|--|------------------|
| Reporting - Documentation and Administration (20% of subtotal) | \$67,000         |
| <b>Total for Project</b>                                       | <b>\$402,000</b> |

**Project: LEE00 Lee Hot Springs**

| <b>Method</b>  | <b>Unit</b> | <b># Units</b> | <b>Cost / unit</b> | <b>Cost Adj.Fact.</b> | <b>Comment</b>  | <b>Cost</b>      |
|--|-------------|----------------|--------------------|-----------------------|---|------------------|
| Drilling: ID slim hole(s)                                      | foot        | 4000           | \$140.00           | 1.0                   | Two holes to 2000 ft each. A decision to drill would be partly contingent on the results of the 3000 ft Oxy hole, if available. | \$560,000        |
| Drilling: ID Slim hole(s): roads and pads                      | well        | 2              | \$50,000.00        | 1.0                   |   | \$100,000        |
| Drilling: ID Slim hole(s): temperature logs                    | well        | 2              | \$5,000.00         | 1.0                   |   | \$10,000         |
| Drilling: TG hole(s)   | foot        | 4000           | \$15.00            | 1.0                   | Eight holes each to 500 ft.   | \$60,000         |
| Geology: field mapping   | project     | 1              | \$20,000.00        | 1.0                   |   | \$20,000         |
| Geophysical survey: gravity                                    | project     | 1              | \$25,000.00        | 1.0                   |   | \$25,000         |
| Geophysical survey: ground magnetics                           | project     | 1              | \$12,500.00        | 1.0                   |   | \$12,500         |
| Reporting - Documentation and Administration (20% of subtotal) |             |                |                    |                       |   | \$157,500        |
| <b>Total for Project</b>                                       |             |                |                    |                       |   | <b>\$945,000</b> |

**Project: LVM00 Long Valley - M-P Leases - M-P Lease Summary**

| <b>Method</b>  | <b>Unit</b> | <b># Units</b> | <b>Cost / unit</b> | <b>Cost Adj.Fact.</b> | <b>Comment</b>   | <b>Cost</b>        |
|--|-------------|----------------|--------------------|-----------------------|--|--------------------|
| Drilling: ID slim hole(s)                                      | foot        | 12000          | \$140.00           | 1.0                   | Four holes each to 3,000 ft at widely spaced locations, to confirm the temperature model of the resource, and to confirm permeability. | \$1,680,000        |
| Drilling: ID Slim hole(s): roads and pads                      | well        | 4              | \$50,000.00        | 1.0                   |  | \$200,000          |
| Drilling: ID Slim hole(s): temperature logs                    | well        | 4              | \$5,000.00         | 1.0                   |  | \$20,000           |
| Well Test: ID slim hole, 3-10 days                             | well        | 4              | \$40,000.00        | 1.0                   | The proposed hole depths are relatively likely to encounter  | \$160,000          |
| Reporting - Documentation and Administration (20% of subtotal) |             |                |                    |                       |  | \$412,000          |
| <b>Total for Project</b>                                       |             |                |                    |                       |  | <b>\$2,472,000</b> |

**Project: MCG00 McGee Mountain - (Painted Hills)**

| <b>Method</b>  | <b>Unit</b> | <b># Units</b> | <b>Cost / unit</b> | <b>Cost Adj.Fact.</b> | <b>Comment</b>   | <b>Cost</b>      |
|--|-------------|----------------|--------------------|-----------------------|--|------------------|
| Drilling: ID slim hole(s)                                      | foot        | 4000           | \$140.00           | 1.0                   | Two holes each to 2000 ft.   | \$560,000        |
| Drilling: ID Slim hole(s): roads and pads                      | well        | 2              | \$50,000.00        | 1.0                   |  | \$100,000        |
| Drilling: ID Slim hole(s): temperature logs                    | well        | 2              | \$5,000.00         | 1.0                   |  | \$10,000         |
| Drilling: TG hole(s)   | foot        | 4000           | \$15.00            | 1.0                   | Eight holes to 500 ft each. Locally rugged topography may make access difficult. | \$60,000         |
| Geology: field mapping   | project     | 1              | \$20,000.00        | 1.0                   | Probably already done (data in private hands)                                    | \$20,000         |
| Geophysical survey: gravity                                    | project     | 1              | \$25,000.00        | 1.0                   |  | \$25,000         |
| Geophysical survey: ground magnetics                           | project     | 1              | \$12,500.00        | 1.0                   |  | \$12,500         |
| Reporting - Documentation and Administration (20% of subtotal) |             |                |                    |                       |  | \$157,500        |
| <b>Total for Project</b>                                       |             |                |                    |                       |  | <b>\$945,000</b> |

**Project: MED01 Medicine Lake - Fourmile Hill**

| <b>Method</b> | <b>Unit</b> | <b># Units</b> | <b>Cost / unit</b> | <b>Cost Adj.Fact.</b> | <b>Comment</b> | <b>Cost</b> |
|---------------|-------------|----------------|--------------------|-----------------------|----------------|-------------|
|---------------|-------------|----------------|--------------------|-----------------------|----------------|-------------|

Reporting - Documentation and Administration (20% of subtotal)

**Total for Project****Project: MED02 Medicine Lake - Telephone Flat**

| <b>Method</b> | <b>Unit</b> | <b># Units</b> | <b>Cost / unit</b> | <b>Cost Adj.Fact.</b> | <b>Comment</b> | <b>Cost</b> |
|---------------|-------------|----------------|--------------------|-----------------------|----------------|-------------|
|---------------|-------------|----------------|--------------------|-----------------------|----------------|-------------|

Reporting - Documentation and Administration (20% of subtotal)

**Total for Project****Project: MOS00 Mount Signal**

| <b>Method</b>  | <b>Unit</b> | <b># Units</b> | <b>Cost / unit</b> | <b>Cost Adj.Fact.</b> | <b>Comment</b>  | <b>Cost</b>      |
|--|-------------|----------------|--------------------|-----------------------|---|------------------|
| Drilling: ID slim hole(s)                                      | foot        | 2000           | \$140.00           | 1.0                   | Drill a second 2000 ft hole, at a location to the E of the existing hole. | \$280,000        |
| Drilling: ID Slim hole(s): roads and pads                      | well        | 1              | \$50,000.00        | 1.0                   |   | \$50,000         |
| Drilling: ID Slim hole(s): temperature logs                    | well        | 1              | \$5,000.00         | 1.0                   |   | \$5,000          |
| Geology: field mapping   | project     | 1              | \$20,000.00        | 1.0                   |   | \$20,000         |
| Geophysical survey: ground magnetics                           | project     | 1              | \$12,500.00        | 1.0                   |   | \$12,500         |
| Reporting - Documentation and Administration (20% of subtotal) |             |                |                    |                       |   | \$73,500         |
| <b>Total for Project</b>                                       |             |                |                    |                       |   | <b>\$441,000</b> |

**Project: NEW00 New York Canyon**

| <b>Method</b>  | <b>Unit</b> | <b># Units</b> | <b>Cost / unit</b> | <b>Cost Adj.Fact.</b> | <b>Comment</b>  | <b>Cost</b>        |
|--|-------------|----------------|--------------------|-----------------------|---|--------------------|
| Drilling: ID slim hole(s)                                      | foot        | 4000           | \$140.00           | 1.0                   | Two holes to 2000 ft each                                     | \$560,000          |
| Drilling: ID Slim hole(s): roads and pads                      | well        | 2              | \$50,000.00        | 1.0                   |   | \$100,000          |
| Drilling: ID Slim hole(s): temperature logs                    | well        | 2              | \$5,000.00         | 1.0                   |   | \$10,000           |
| Drilling: TG hole(s)   | foot        | 4000           | \$15.00            | 1.0                   | Eight holes to 500 ft each                                    | \$60,000           |
| Geology: field mapping   | project     | 1              | \$20,000.00        | 1.0                   |   | \$20,000           |
| Geophysical survey: gravity                                    | project     | 1              | \$25,000.00        | 1.0                   |   | \$25,000           |
| Geophysical survey: ground magnetics                           | project     | 1              | \$12,500.00        | 1.0                   |   | \$12,500           |
| Geophysical survey: MT or DC resistivity                       | project     | 1              | \$200,000.00       | 1.0                   | This expense may be warranted by the high TG at TD in hole BV | \$200,000          |
| Reporting - Documentation and Administration (20% of subtotal) |             |                |                    |                       |   | \$197,500          |
| <b>Total for Project</b>                                       |             |                |                    |                       |   | <b>\$1,185,000</b> |

**Project: NIL00 Niland**

| <b>Method</b>  | <b>Unit</b> | <b># Units</b> | <b>Cost / unit</b> | <b>Cost Adj.Fact.</b> | <b>Comment</b> | <b>Cost</b> |
|--|-------------|----------------|--------------------|-----------------------|----------------|-------------|
| No additional exploration is likely to be needed.              |             |                |                    |                       |                |             |
| Reporting - Documentation and Administration (20% of subtotal) |             |                |                    |                       |                |             |
| <b>Total for Project</b>                                       |             |                |                    |                       |                |             |

**Project: NOR00 North Valley**

| <b>Method</b>  | <b>Unit</b> | <b># Units</b> | <b>Cost / unit</b> | <b>Cost Adj.Fact.</b> | <b>Comment</b>   | <b>Cost</b> |
|--|-------------|----------------|--------------------|-----------------------|--|-------------|
| Geology: field mapping   | project     | 1              | \$20,000.00        | 1.0                   |  | \$20,000    |
| Geophysical survey: ground magnetics                           | project     | 1              | \$12,500.00        | 1.0                   |  | \$12,500    |
| Geophysical survey: MT or DC resistivity                       | project     | 1              | \$200,000.00       | 1.0                   | May help define depth and areal extent of deep permeability (high-risk expense). | \$200,000   |
| Reporting - Documentation and Administration (20% of subtotal) |             |                |                    |                       |  |             |
| <b>Total for Project</b>                                       |             |                |                    |                       |  | \$46,500    |
|  |             |                |                    |                       |  | \$279,000   |

**Project: PIN00 Pinto Hot Springs**

| <b>Method</b>  | <b>Unit</b> | <b># Units</b> | <b>Cost / unit</b> | <b>Cost Adj.Fact.</b> | <b>Comment</b>  | <b>Cost</b> |
|--|-------------|----------------|--------------------|-----------------------|---|-------------|
| Drilling: ID slim hole(s)                                      | foot        | 4000           | \$140.00           | 1.0                   | Two holes to 2000 ft each.  | \$560,000   |
| Drilling: ID Slim hole(s): roads and pads                      | well        | 2              | \$50,000.00        | 1.0                   |   | \$100,000   |
| Drilling: ID Slim hole(s): temperature logs                    | well        | 2              | \$5,000.00         | 1.0                   |   | \$10,000    |
| Drilling: TG hole(s)   | foot        | 8000           | \$15.00            | 1.0                   | Six holes to 500 ft on each of the E and W sides, plus four holes in the area between the two hot springs | \$120,000   |
| Geology: field mapping   | project     | 1              | \$20,000.00        | 1.0                   |   | \$20,000    |
| Geophysical survey: gravity                                    | project     | 1              | \$25,000.00        | 1.0                   |   | \$25,000    |
| Geophysical survey: ground magnetics                           | project     | 1              | \$12,500.00        | 1.0                   |   | \$12,500    |
| Reporting - Documentation and Administration (20% of subtotal) |             |                |                    |                       |   |             |
| <b>Total for Project</b>                                       |             |                |                    |                       |   | \$169,500   |
|  |             |                |                    |                       |   | \$1,017,000 |

**Project: PIR00 Pirouette Mountain - (S.Dixie Valley)**

| <b>Method</b>                               | <b>Unit</b> | <b># Units</b> | <b>Cost / unit</b> | <b>Cost Adj.Fact.</b> | <b>Comment</b>  | <b>Cost</b> |
|---|-------------|----------------|--------------------|-----------------------|---|-------------|
| Drilling: ID slim hole(s)                   | foot        | 6000           | \$140.00           | 1.0                   | A deep ID Slim hole to test for permeability and temperature. A developer might choose to proceed directly to full-diameter drilling (calculated as confirmation cost). | \$840,000   |
| Drilling: ID Slim hole(s): roads and pads   | well        | 1              | \$50,000.00        | 1.0                   |   | \$50,000    |
| Drilling: ID Slim hole(s): temperature logs | well        | 1              | \$5,000.00         | 1.0                   |   | \$5,000     |
| Geophysical survey: gravity                 | project     | 1              | \$25,000.00        | 1.0                   |   | \$25,000    |

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|  |         |   |             |     |  |                    |
|--|---------|---|-------------|-----|--|--------------------|
| Geophysical survey: gravity                                    | project | 1 | \$25,000.00 | 1.0 |  | \$25,000           |
| Well Test: ID slim hole, 3-10 days                             | well    | 1 | \$40,000.00 | 1.0 |  | \$40,000           |
| Reporting - Documentation and Administration (20% of subtotal) |         |   |             |     |  | \$197,000          |
| <b>Total for Project</b>                                       |         |   |             |     |  | <b>\$1,182,000</b> |

**Project: PUM00 Pumpernickel Valley - Tipton Ranch/Hot Springs Ranch**

| <b>Method</b>  | <b>Unit</b> | <b># Units</b> | <b>Cost / unit</b> | <b>Cost Adj.Fact.</b> | <b>Comment</b>              | <b>Cost</b>      |
|--|-------------|----------------|--------------------|-----------------------|-----------------------------|------------------|
| Drilling: TG hole(s)   | foot        | 4000           | \$15.00            | 1.0                   | Eight holes each to 500 ft. | \$60,000         |
| Geology: field mapping   | project     | 1              | \$20,000.00        | 1.0                   |                             | \$20,000         |
| Geophysical survey: gravity                                    | project     | 1              | \$25,000.00        | 1.0                   |                             | \$25,000         |
| Geophysical survey: ground magnetics                           | project     | 1              | \$12,500.00        | 1.0                   |                             | \$12,500         |
| Reporting - Documentation and Administration (20% of subtotal) |             |                |                    |                       |                             | \$23,500         |
| <b>Total for Project</b>                                       |             |                |                    |                       |                             | <b>\$141,000</b> |

**Project: PYR00 Pyramid Lake Indian Reserv. - (Needle Rocks Hot Springs)**

| <b>Method</b>  | <b>Unit</b> | <b># Units</b> | <b>Cost / unit</b> | <b>Cost Adj.Fact.</b> | <b>Comment</b>             | <b>Cost</b>      |
|--|-------------|----------------|--------------------|-----------------------|----------------------------|------------------|
| Drilling: TG hole(s)   | foot        | 4000           | \$15.00            | 1.0                   | Eight holes to 500 ft each | \$60,000         |
| Geology: field mapping   | project     | 1              | \$20,000.00        | 1.0                   |                            | \$20,000         |
| Geophysical survey: gravity                                    | project     | 1              | \$25,000.00        | 1.0                   |                            | \$25,000         |
| Geophysical survey: ground magnetics                           | project     | 1              | \$12,500.00        | 1.0                   |                            | \$12,500         |
| Reporting - Documentation and Administration (20% of subtotal) |             |                |                    |                       |                            | \$23,500         |
| <b>Total for Project</b>                                       |             |                |                    |                       |                            | <b>\$141,000</b> |

**Project: RAN00 Randsburg**

| <b>Method</b>  | <b>Unit</b> | <b># Units</b> | <b>Cost / unit</b> | <b>Cost Adj.Fact.</b> | <b>Comment</b>   | <b>Cost</b>      |
|--|-------------|----------------|--------------------|-----------------------|--|------------------|
| Drilling: ID slim hole(s)                                      | foot        | 2000           | \$140.00           | 1.0                   | To duplicate the Phillips ID Slim Hole, if data from that hole cannot be obtained. | \$280,000        |
| Drilling: ID Slim hole(s): roads and pads                      | well        | 1              | \$50,000.00        | 1.0                   |  | \$50,000         |
| Drilling: ID Slim hole(s): temperature logs                    | well        | 1              | \$5,000.00         | 1.0                   |  | \$5,000          |
| Well Test: ID slim hole, 3-10 days                             | well        | 1              | \$40,000.00        | 1.0                   |  | \$40,000         |
| Reporting - Documentation and Administration (20% of subtotal) |             |                |                    |                       |  | \$75,000         |
| <b>Total for Project</b>                                       |             |                |                    |                       |  | <b>\$450,000</b> |

**Project: RYE01 Rye Patch-Humboldt House District - Rye Patch**

| <b>Method</b> | <b>Unit</b> | <b># Units</b> | <b>Cost / unit</b> | <b>Cost Adj.Fact.</b> | <b>Comment</b> | <b>Cost</b> |
|---------------|-------------|----------------|--------------------|-----------------------|----------------|-------------|
|---------------|-------------|----------------|--------------------|-----------------------|----------------|-------------|

The area has been very extensively explored. Confirmation wells need to be sited on the basis of a thorough integration of the existing data.

Reporting - Documentation and Administration (20% of subtotal)

**Total for Project**

**Project: RYE02 Rye Patch-Humboldt House District - Humboldt House**

| <b>Method</b> | <b>Unit</b> | <b># Units</b> | <b>Cost / unit</b> | <b>Cost Adj.Fact.</b> | <b>Comment</b>   | <b>Cost</b> |
|---------------|-------------|----------------|--------------------|-----------------------|--|-------------|
|               |             |                |                    |                       | It is assumed that abundant exploration data are already in private hands and that no more exploration should be needed to site the first deep confirmation hole. However, if this is not the case, then additional exploration will be warranted. Methods of primary interest may include gravimetry and ID Slim hole drilling. |             |

Reporting - Documentation and Administration (20% of subtotal)

**Total for Project**

**Project: SAL00 Salton Sea - Field-wide summary**

| <b>Method</b> | <b>Unit</b> | <b># Units</b> | <b>Cost / unit</b> | <b>Cost Adj.Fact.</b> | <b>Comment</b>                              | <b>Cost</b> |
|---------------|-------------|----------------|--------------------|-----------------------|---|-------------|
|               |             |                |                    |                       | No additional exploration should be needed. |             |

Reporting - Documentation and Administration (20% of subtotal)

**Total for Project**

**Project: SAW00 Salt Wells - Eight Mile Flat**

| <b>Method</b>                               | <b>Unit</b> | <b># Units</b> | <b>Cost / unit</b> | <b>Cost Adj.Fact.</b> | <b>Comment</b>   | <b>Cost</b> |
|---|-------------|----------------|--------------------|-----------------------|--|-------------|
|   |             |                |                    | 1.0                   |  |             |
| Drilling: ID slim hole(s)                   | foot        | 4000           | \$140.00           | 1.0                   | Additional ID Slim hole drilling is regarded as necessary to site another deep confirmation well. Four holes each to 1000 ft are | \$560,000   |
| Drilling: ID Slim hole(s): roads and pads   | well        | 4              | \$50,000.00        | 1.0                   |  | \$200,000   |
| Drilling: ID Slim hole(s): temperature logs | well        | 4              | \$5,000.00         | 1.0                   |  | \$20,000    |
| Geophysical survey: gravity                 | project     | 1              | \$25,000.00        | 1.0                   | Assumed not yet done   | \$25,000    |
| Geophysical survey: ground magnetics        | project     | 1              | \$12,500.00        | 1.0                   | Assumed not yet done   | \$12,500    |

Reporting - Documentation and Administration (20% of subtotal)

**Total for Project**

**Project: SES00 Sespe Hot Springs**

| <b>Method</b>             | <b>Unit</b> | <b># Units</b> | <b>Cost / unit</b> | <b>Cost Adj.Fact.</b> | <b>Comment</b>             | <b>Cost</b> |
|---------------------------|-------------|----------------|--------------------|-----------------------|----------------------------|-------------|
| Drilling: ID slim hole(s) | foot        | 4000           | \$140.00           | 1.0                   | Two holes each to 2000 ft. | \$560,000   |

|  |         |      |             |     |                            |                  |
|--|---------|------|-------------|-----|----------------------------|------------------|
| Drilling: ID Slim hole(s): roads and pads                      | well    | 2    | \$50,000.00 | 1.0 |                            | \$100,000        |
| Drilling: ID Slim hole(s): temperature logs                    | well    | 2    | \$5,000.00  | 1.0 |                            | \$10,000         |
| Drilling: TG hole(s)   | foot    | 4000 | \$15.00     | 1.0 | Eight holes each to 500 ft | \$60,000         |
| Geology: field mapping   | project | 1    | \$20,000.00 | 1.0 |                            | \$20,000         |
| Geophysical survey: gravity                                    | project | 1    | \$25,000.00 | 1.0 |                            | \$25,000         |
| Geophysical survey: ground magnetics                           | project | 1    | \$12,500.00 | 1.0 |                            | \$12,500         |
| Reporting - Documentation and Administration (20% of subtotal) |         |      |             |     |                            | \$157,500        |
| <b>Total for Project</b>                                       |         |      |             |     |                            | <b>\$945,000</b> |

**Project: SHO00 Shoshone-Reese River**

| <b>Method</b>  | <b>Unit</b> | <b># Units</b> | <b>Cost / unit</b> | <b>Cost Adj.Fact.</b> | <b>Comment</b>            | <b>Cost</b>      |
|--|-------------|----------------|--------------------|-----------------------|---------------------------|------------------|
| Drilling: ID slim hole(s)                                      | foot        | 4000           | \$140.00           | 1.0                   | Two holes each to 2000 ft | \$560,000        |
| Drilling: ID Slim hole(s): roads and pads                      | well        | 2              | \$50,000.00        | 1.0                   |                           | \$100,000        |
| Drilling: ID Slim hole(s): temperature logs                    | well        | 2              | \$5,000.00         | 1.0                   |                           | \$10,000         |
| Geology: field mapping   | project     | 1              | \$20,000.00        | 1.0                   |                           | \$20,000         |
| Geophysical survey: gravity                                    | project     | 1              | \$25,000.00        | 1.0                   |                           | \$25,000         |
| Geophysical survey: ground magnetics                           | project     | 1              | \$12,500.00        | 1.0                   |                           | \$12,500         |
| Reporting - Documentation and Administration (20% of subtotal) |             |                |                    |                       |                           | \$145,500        |
| <b>Total for Project</b>                                       |             |                |                    |                       |                           | <b>\$873,000</b> |

**Project: SIL00 Silver Peak - (Alum prospect)**

| <b>Method</b>  | <b>Unit</b> | <b># Units</b> | <b>Cost / unit</b> | <b>Cost Adj.Fact.</b> | <b>Comment</b>   | <b>Cost</b>     |
|--|-------------|----------------|--------------------|-----------------------|--|-----------------|
| Other  | project     | 1              | \$10,000.00        | 3.0                   | Cost for a thorough study and integration of existing exploration data (in private hands but assumed available) to enable siting a deep confirmation well. If hole 56-29 did indeed flow, and if water samples were analysed, these should be evaluated for indications of deep temperature. | \$30,000        |
| Reporting - Documentation and Administration (20% of subtotal) |             |                |                    |                       |  | \$6,000         |
| <b>Total for Project</b>                                       |             |                |                    |                       |  | <b>\$36,000</b> |

**Project: SOD00 Soda Lake - Soda Lake No.1/No.2**

| <b>Method</b>  | <b>Unit</b> | <b># Units</b> | <b>Cost / unit</b> | <b>Cost Adj.Fact.</b> | <b>Comment</b>  | <b>Cost</b>     |
|--|-------------|----------------|--------------------|-----------------------|---|-----------------|
| Other  | project     | 1              | \$10,000.00        | 5.0                   | Cost for a thorough study of existing data to enable siting additional wells. | \$50,000        |
| Reporting - Documentation and Administration (20% of subtotal) |             |                |                    |                       |   | \$10,000        |
| <b>Total for Project</b>                                       |             |                |                    |                       |   | <b>\$60,000</b> |

**Project: SOH00    Sou Hot Springs - (Seven Devils/Gilbert's H.S.)**

| <b>Method</b>  | <b>Unit</b> | <b># Units</b> | <b>Cost / unit</b> | <b>Cost Adj.Fact.</b> | <b>Comment</b>              | <b>Cost</b>      |
|--|-------------|----------------|--------------------|-----------------------|-----------------------------|------------------|
| Drilling: ID slim hole(s)                                      | foot        | 4000           | \$140.00           | 1.0                   | Two holes to 2000 ft each.  | \$560,000        |
| Drilling: ID Slim hole(s): roads and pads                      | well        | 2              | \$50,000.00        | 1.0                   |                             | \$100,000        |
| Drilling: ID Slim hole(s): temperature logs                    | well        | 2              | \$5,000.00         | 1.0                   |                             | \$10,000         |
| Drilling: TG hole(s)   | foot        | 4000           | \$15.00            | 1.0                   | Eight holes to 500 ft each. | \$60,000         |
| Geophysical survey: gravity                                    | project     | 1              | \$25,000.00        | 1.0                   |                             | \$25,000         |
| Geophysical survey: ground magnetics                           | project     | 1              | \$12,500.00        | 1.0                   |                             | \$12,500         |
| Reporting - Documentation and Administration (20% of subtotal) |             |                |                    |                       |                             | \$153,500        |
| <b>Total for Project</b>                                       |             |                |                    |                       |                             | <b>\$921,000</b> |

**Project: STE00    Steamboat Hot Sprs - Field-wide Summary**

| <b>Method</b>  | <b>Unit</b> | <b># Units</b> | <b>Cost / unit</b> | <b>Cost Adj.Fact.</b> | <b>Comment</b>                     | <b>Cost</b> |
|--|-------------|----------------|--------------------|-----------------------|------------------------------------|-------------|
|  |             |                |                    |                       | Already very extensively explored. |             |
| Reporting - Documentation and Administration (20% of subtotal) |             |                |                    |                       |                                    |             |
| <b>Total for Project</b>                                       |             |                |                    |                       |                                    |             |

**Project: STI00    Stillwater - Stillwater Geothermal 1**

| <b>Method</b>  | <b>Unit</b> | <b># Units</b> | <b>Cost / unit</b> | <b>Cost Adj.Fact.</b> | <b>Comment</b>  | <b>Cost</b> |
|--|-------------|----------------|--------------------|-----------------------|---|-------------|
|  |             |                |                    |                       | It is assumed that no additional exploration is needed. |             |
| Reporting - Documentation and Administration (20% of subtotal) |             |                |                    |                       |   |             |
| <b>Total for Project</b>                                       |             |                |                    |                       |   |             |

**Project: STI01    Stillwater - Stillwater N Expansion**

| <b>Method</b>  | <b>Unit</b> | <b># Units</b> | <b>Cost / unit</b> | <b>Cost Adj.Fact.</b> | <b>Comment</b>  | <b>Cost</b> |
|--|-------------|----------------|--------------------|-----------------------|---|-------------|
|  |             |                |                    |                       | It is assumed that no additional exploration is needed. |             |
| Reporting - Documentation and Administration (20% of subtotal) |             |                |                    |                       |   |             |
| <b>Total for Project</b>                                       |             |                |                    |                       |   |             |

**Project: SUL00    Sulphur Bank - Clear Lake**

| <b>Method</b>  | <b>Unit</b> | <b># Units</b> | <b>Cost / unit</b> | <b>Cost Adj.Fact.</b> | <b>Comment</b>  | <b>Cost</b> |
|--|-------------|----------------|--------------------|-----------------------|---|-------------|
|  |             |                |                    |                       | It appears that additional exploration is not needed. |             |
| Reporting - Documentation and Administration (20% of subtotal) |             |                |                    |                       |   |             |
| <b>Total for Project</b>                                       |             |                |                    |                       |   |             |

**Project: SUP00      Superstition Mountain**

| <b>Method</b>  | <b>Unit</b> | <b># Units</b> | <b>Cost / unit</b> | <b>Cost Adj.Fact.</b> | <b>Comment</b>             | <b>Cost</b>      |
|--|-------------|----------------|--------------------|-----------------------|----------------------------|------------------|
| Drilling: ID slim hole(s)                                      | foot        | 4000           | \$140.00           | 1.0                   | Two holes each to 2000 ft. | \$560,000        |
| Drilling: ID Slim hole(s): roads and pads                      | well        | 2              | \$50,000.00        | 1.0                   |                            | \$100,000        |
| Drilling: ID Slim hole(s): temperature logs                    | well        | 2              | \$5,000.00         | 1.0                   |                            | \$10,000         |
| Geophysical survey: gravity                                    | project     | 1              | \$25,000.00        | 1.0                   |                            | \$25,000         |
| Geophysical survey: ground magnetics                           | project     | 1              | \$12,500.00        | 1.0                   |                            | \$12,500         |
| Reporting - Documentation and Administration (20% of subtotal) |             |                |                    |                       |                            | \$141,500        |
| <b>Total for Project</b>                                       |             |                |                    |                       |                            | <b>\$849,000</b> |

**Project: TRI00      Trinity Mountains District - Telephone Well area**

| <b>Method</b>  | <b>Unit</b> | <b># Units</b> | <b>Cost / unit</b> | <b>Cost Adj.Fact.</b> | <b>Comment</b>  | <b>Cost</b>      |
|--|-------------|----------------|--------------------|-----------------------|---|------------------|
| Drilling: ID slim hole(s)                                      | foot        | 4000           | \$140.00           | 1.0                   | Two holes each to 2000 ft, in the area of Telephone Well.           | \$560,000        |
| Drilling: ID Slim hole(s): roads and pads                      | well        | 2              | \$50,000.00        | 1.0                   |   | \$100,000        |
| Drilling: ID Slim hole(s): temperature logs                    | well        | 2              | \$5,000.00         | 1.0                   |   | \$10,000         |
| Drilling: TG hole(s)   | foot        | 4000           | \$15.00            | 1.0                   | Eight holes, each to 500 ft, in the general area of Telephone Well. | \$60,000         |
| Geology: field mapping   | project     | 1              | \$20,000.00        | 1.0                   |   | \$20,000         |
| Geophysical survey: gravity                                    | project     | 1              | \$25,000.00        | 1.0                   |   | \$25,000         |
| Geophysical survey: ground magnetics                           | project     | 1              | \$12,500.00        | 1.0                   |   | \$12,500         |
| Reporting - Documentation and Administration (20% of subtotal) |             |                |                    |                       |   | \$157,500        |
| <b>Total for Project</b>                                       |             |                |                    |                       |   | <b>\$945,000</b> |

**Project: WAB00      Wabuska**

| <b>Method</b>  | <b>Unit</b> | <b># Units</b> | <b>Cost / unit</b> | <b>Cost Adj.Fact.</b> | <b>Comment</b>  | <b>Cost</b>      |
|--|-------------|----------------|--------------------|-----------------------|---|------------------|
| Drilling: ID Slim hole(s): temperature logs                    | well        | 5              | \$5,000.00         | 1.0                   | Re-logging of existing holes (assumed available)  | \$25,000         |
| Geophysical survey: gravity                                    | project     | 1              | \$25,000.00        | 1.0                   |   | \$25,000         |
| Geophysical survey: ground magnetics                           | project     | 1              | \$12,500.00        | 1.0                   |   | \$12,500         |
| Other  | project     | 1              | \$10,000.00        | 4.0                   | Intgration of existing data to establish a conceptual model of the resource and assist further well siting. | \$40,000         |
| Reporting - Documentation and Administration (20% of subtotal) |             |                |                    |                       |   | \$20,500         |
| <b>Total for Project</b>                                       |             |                |                    |                       |   | <b>\$123,000</b> |

**Project: WIL00      Wilson Hot Springs**

| <b>Method</b>             | <b>Unit</b> | <b># Units</b> | <b>Cost / unit</b> | <b>Cost Adj.Fact.</b> | <b>Comment</b>                                  | <b>Cost</b> |
|---------------------------|-------------|----------------|--------------------|-----------------------|---|-------------|
| Drilling: ID slim hole(s) | foot        | 4000           | \$140.00           | 1.0                   | One hole to 4,000 ft., or two to 2,000 ft each. | \$560,000   |

|  |         |   |             |     |                            |
|--|---------|---|-------------|-----|----------------------------|
| Geology: field mapping   | project | 1 | \$20,000.00 | 1.0 | \$20,000                   |
| Geophysical survey: gravity                                    | project | 1 | \$25,000.00 | 1.0 | \$25,000                   |
| Geophysical survey: ground magnetics                           | project | 1 | \$12,500.00 | 1.0 | \$12,500                   |
| Reporting - Documentation and Administration (20% of subtotal) |         |   |             |     | \$123,500                  |
| <b><i>Total for Project</i></b>                                |         |   |             |     | <b><i>\$741,000</i></b>    |
| <b><i>Grand Total all Projects</i></b>                         |         |   |             |     | <b><i>\$27,784,200</i></b> |

**Hetch Hetchy/SFPUC Programmatic Renewable Energy Project**  
**Project: 1.3 New Geothermal Site Identification and Qualification**  
**Project Team: GeothermEx, Inc.**  
**Task: 1.3.10 Final Project Report**  
**Subject: D.1.3.10.3 Final Report**

**Table 8: Exploration, Confirmation and Site Development Cost Estimates – Summary with Cost Totals <sup>(1)</sup>**

|                                    |                                 | Estimated Costs in thousands <sup>(4)</sup> |                           |                          |                         |                                       |                |                      |          |            |   |                |                      |          |            |
|------------------------------------|---------------------------------|---|---------------------------|--------------------------|-------------------------|---------------------------------------|----------------|----------------------|----------|------------|---|----------------|----------------------|----------|------------|
| PROJ ID                            | Field or Area                   | Area or Power Plant                         | (2)                       | (3)                      | Explor-<br>ation<br>(E) | Minimum Estimated Generation Capacity |                |                      |          |            | Most-likely Estimated Generation Capacity |                |                      |          |            |
|                                    |                                 |   | Explor-<br>Devel.<br>Cat. | Existing<br>Wellhd<br>MW |                         | MW                                    | Confirm<br>(C) | Develop Site<br>(SD) | E+C      | E+C+<br>SD | MW  | Confirm<br>(C) | Develop Site<br>(SD) | E+C      | E+C+<br>SD |
| Area: 1 - Greater Reno (NV and CA) |                                 |   |                           |                          |                         |                                       |                |                      |          |            |   |                |                      |          |            |
| BEO00                              | Beowawe                         |   | A                         | 15 / 0                   |                         | 30                                    | \$4,930        | \$48,048             | \$4,930  | \$52,978   | 41  | \$9,675        | \$84,618             | \$9,675  | \$94,293   |
| BLU00                              | Blue Mountain                   |   | C                         | 0 / 0                    | \$48                    | 16                                    | \$3,110        | \$36,376             | \$3,158  | \$39,534   | 30  | \$6,112        | \$67,277             | \$6,160  | \$73,437   |
| BRA00                              | Brady's Hot Springs             |   | A                         | 15 / 0                   |                         | 11                                    | \$0            | \$0                  | \$0      | \$0        | 18  | \$2,927        | \$7,233              | \$2,927  | \$10,160   |
| COL00                              | Colado                          |   | C                         | 0 / 0                    | \$924                   | 3.7                                   | \$2,086        | \$13,600             | \$3,010  | \$16,610   | 6.2                                       | \$2,086        | \$22,180             | \$3,010  | \$25,190   |
| DES00                              | Desert Peak                     |   | A                         | 10 / 0                   |                         | 33                                    | \$4,848        | \$54,703             | \$4,848  | \$59,551   | 45  | \$7,257        | \$82,568             | \$7,257  | \$89,825   |
| EMP00                              | Empire (San Emidio)             | Field-wide summary                          | A                         | 4.8 / 0                  |                         | 4.3                                   | \$0            | \$0                  | \$0      | \$0        | 6.6                                       | \$1,593        | \$6,276              | \$1,593  | \$7,869    |
| FAL00                              | Fallon / Carson Lake            | Carson Lake anomaly                         | C                         | 0 / 0                    | \$48                    | 34                                    | \$11,808       | \$94,956             | \$11,856 | \$106,812  | 55  | \$17,735       | \$145,992            | \$17,783 | \$163,775  |
| FLY00                              | Fly Ranch/Granite Ranch         | Ward's (Fly/Hualapi Flat) H.S.              | C                         | 0 / 0                    |                         | 6                                     | \$15,981       | \$59,832             | \$15,981 | \$75,813   | 8.7                                       | \$19,986       | \$83,100             | \$19,986 | \$103,086  |
| FLY01                              | Fly Ranch/Granite Ranch         | Granite Ranch                               | C                         | 0 / 0                    | \$601                   | 5.4                                   | \$2,615        | \$14,271             | \$3,216  | \$17,487   | 8.1                                       | \$2,615        | \$22,435             | \$3,216  | \$25,651   |
| GER00                              | Gerlach                         | (Great Boiling Spring)                      | C                         | 0 / 0                    | \$36                    | 17                                    | \$7,250        | \$55,380             | \$7,286  | \$62,666   | 25  | \$10,858       | \$82,320             | \$10,894 | \$93,214   |
| HAZ00                              | Hazen (Black Butte)             | (Patua Hot Springs)                         | C                         | 0 / 0                    | \$1,003                 | 6.3                                   | \$3,010        | \$21,402             | \$4,013  | \$25,415   | 8.5                                       | \$3,010        | \$24,702             | \$4,013  | \$28,715   |
| HON00                              | Honey Lake                      | Area-wide Summary                           | A                         | 1.2 / 0                  |                         | 5.7                                   | \$1,716        | \$10,368             | \$1,716  | \$12,084   | 8.3                                       | \$3,249        | \$15,810             | \$3,249  | \$19,059   |
| KYL00                              | Kyle Hot Springs (Granite Mtn.) | (Buena Vista Valley)                        | C                         | 0 / 0                    | \$822                   | 16                                    | \$7,250        | \$47,904             | \$8,072  | \$55,976   | 22  | \$7,250        | \$62,880             | \$8,072  | \$70,952   |
| LEA00                              | Leach Hot Springs               | Grass Valley                                | C                         | 0 / 0                    | \$402                   | 13                                    | \$12,334       | \$70,560             | \$12,736 | \$83,296   | 18  | \$16,435       | \$95,080             | \$16,837 | \$111,917  |
| LEE00                              | Lee Hot Springs                 |   | C                         | 0 / 0                    | \$945                   | 5.4                                   | \$2,615        | \$18,385             | \$3,560  | \$21,945   | 9.4                                       | \$2,615        | \$30,556             | \$3,560  | \$34,116   |
| NEW00                              | New York Canyon                 |   | C                         | 0 / 0                    | \$1,185                 | 20                                    | \$5,048        | \$56,741             | \$6,233  | \$62,974   | 26  | \$7,556        | \$69,855             | \$8,741  | \$78,596   |

|               |                                   |                                | Estimated Costs in thousands <sup>(4)</sup> |                          |                         |                                       |                |                 |           |             |   |                |                 |           |             |
|---------------|-----------------------------------|--------------------------------|---|--------------------------|-------------------------|---------------------------------------|----------------|-----------------|-----------|-------------|---|----------------|-----------------|-----------|-------------|
| PROJ ID       | Field or Area                     | Area or Power Plant            | (2)   | (3)                      | Explor-<br>ation<br>(E) | Minimum Estimated Generation Capacity |                |                 |           |             | Most-likely Estimated Generation Capacity |                |                 |           |             |
|               |                                   |                                | Explor-<br>Devel.<br>Cat.                   | Existing<br>Wellhd<br>MW |                         | MW                                    | Confirm<br>(C) | Develop<br>(SD) | E+C       | E+C+<br>SD  | MW  | Confirm<br>(C) | Develop<br>(SD) | E+C       | E+C+<br>SD  |
| NOR00         | North Valley                      |                                | C   | 0 / 0                    | \$279                   | 37                                    | \$10,668       | \$95,704        | \$10,947  | \$106,651   | 49  | \$12,810       | \$124,192       | \$13,089  | \$137,281   |
| PUM00         | Pumpnickel Valley                 | Tipton Ranch/Hot Springs Ranch | C   | 0 / 0.9                  | \$141                   | 10                                    | \$2,768        | \$32,496        | \$2,909   | \$35,405    | 13  | \$5,356        | \$41,370        | \$5,497   | \$46,867    |
| PYR00         | Pyramid Lake Indian Reserv.       | (Needle Rocks Hot Springs)     | C   | 0 / 0                    | \$141                   | 9.9                                   | \$3,310        | \$28,075        | \$3,451   | \$31,526    | 14  | \$6,437        | \$42,160        | \$6,578   | \$48,738    |
| RYE01         | Rye Patch-Humboldt House District | Rye Patch                      | B   | 0 / 10                   |                         | 16                                    | \$0            | \$25,911        | \$0       | \$25,911    | 20  | \$0            | \$37,554        | \$0       | \$37,554    |
| RYE02         | Rye Patch-Humboldt House District | Humboldt House                 | C   | 0 / 0                    |                         | 27                                    | \$7,556        | \$71,355        | \$7,556   | \$78,911    | 34  | \$10,062       | \$92,140        | \$10,062  | \$102,202   |
| SAW00         | Salt Wells                        | Eight Mile Flat                | C   | 0 / 0                    | \$981                   | 63                                    | \$15,003       | \$143,868       | \$15,984  | \$159,852   | 96  | \$22,376       | \$222,166       | \$23,357  | \$245,523   |
| SOD00         | Soda Lake                         | Soda Lake No.1/No.2            | A   | 16 / 0                   | \$60                    | 29                                    | \$2,202        | \$22,796        | \$2,262   | \$25,058    | 42  | \$7,558        | \$58,693        | \$7,618   | \$66,311    |
| STE00         | Steamboat Hot Sprs                | Field-wide Summary             | A   | 53 / 0                   |                         | 56                                    | \$0            | \$1,462         | \$0       | \$1,462     | 62  | \$1,048        | \$7,627         | \$1,048   | \$8,675     |
| STI00         | Stillwater                        | Stillwater Geothermal 1A       |   | 14 / 0                   |                         | 11                                    | \$0            | \$0             | \$0       | \$0         | 18  | \$0            | \$0             | \$0       | \$0         |
| STI01         | Stillwater                        | Stillwater N Expansion         | B   | 0 / 5                    |                         | 16                                    | \$0            | \$23,603        | \$0       | \$23,603    | 24  | \$1,167        | \$39,761        | \$1,167   | \$40,928    |
| TRI00         | Trinity Mountains District        | Telephone Well area            | D   | 0 / 0                    | \$945                   | 42                                    | \$12,247       | \$113,375       | \$13,192  | \$126,567   | 66  | \$19,546       | \$177,585       | \$20,491  | \$198,076   |
| WAB00         | Wabuska                           |                                | A   | 1.4 / 0                  | \$123                   | 8.1                                   | \$3,900        | \$35,127        | \$4,023   | \$39,150    | 13  | \$5,835        | \$61,341        | \$5,958   | \$67,299    |
| Area Totals : |                                   |                                |   | 130                      | \$8,684                 |                                       | \$142,255      | \$1,196,299     |           | \$1,347,238 |   | \$213,154      | \$1,807,471     |           | \$2,029,309 |
|               |                                   |                                |   | 16                       |                         | 552                                   |                |                 | \$150,939 |             | 787                                       |                |                 | \$221,838 |             |

**Area: 2 - NV with direct access to CA**

|       |                         |                                    |   |        |       |     |          |           |          |           |     |          |           |          |           |
|-------|-------------------------|------------------------------------|---|--------|-------|-----|----------|-----------|----------|-----------|-----|----------|-----------|----------|-----------|
| AUR00 | Aurora                  |                                    | C | 0 / 0  | \$858 | 31  | \$10,602 | \$85,866  | \$11,460 | \$97,326  | 51  | \$15,925 | \$139,923 | \$16,783 | \$156,706 |
| DIX00 | Dixie Valley            | Caithness Dixie Valley             | A | 66 / 0 |       | 71  | \$4,862  | \$14,623  | \$4,862  | \$19,485  | 107 | \$7,202  | \$116,107 | \$7,202  | \$123,309 |
| DIX01 | Dixie Valley            | Dixie Valley Power Partners (DVPP) | C | 0 / 0  | \$60  | 107 | \$40,669 | \$300,684 | \$40,729 | \$341,413 | 151 | \$55,889 | \$421,908 | \$55,949 | \$477,857 |
| EMI00 | Emigrant (Fish Lake V.) |                                    | C | 0 / 0  | \$48  | 49  | \$21,608 | \$160,152 | \$21,656 | \$181,808 | 85  | \$39,425 | \$279,888 | \$39,473 | \$319,361 |
| FIS00 | Fish Lake (Valley)      |                                    | B | 0 / 7  | \$72  | 30  | \$4,862  | \$104,355 | \$4,934  | \$109,289 | 47  | \$9,542  | \$169,425 | \$9,614  | \$179,039 |
| HAW00 | Hawthorne               |                                    | C | 0 / 0  | \$36  | 8.7 | \$5,885  | \$32,338  | \$5,921  | \$38,259  | 14  | \$8,812  | \$52,343  | \$8,848  | \$61,191  |
| HYD00 | Hyder Hot Springs       |                                    | D | 0 / 0  | \$843 | 5.5 | \$7,250  | \$32,154  | \$8,093  | \$40,247  | 9.6 | \$10,858 | \$53,244  | \$11,701 | \$64,945  |

| Estimated Costs in thousands <sup>(4)</sup> |                               |                                |                           |                          |                         |                                       |                |                      |           |             |   |                |                      |           |             |
|---|-------------------------------|--------------------------------|---------------------------|--------------------------|-------------------------|---------------------------------------|----------------|----------------------|-----------|-------------|---|----------------|----------------------|-----------|-------------|
| PROJ ID                                     | Field or Area                 | Area or Power Plant            | (2)                       | (3)                      | Explor-<br>ation<br>(E) | Minimum Estimated Generation Capacity |                |                      |           |             | Most-likely Estimated Generation Capacity |                |                      |           |             |
|   |                               |                                | Explor-<br>Devel.<br>Cat. | Existing<br>Wellhd<br>MW |                         | MW                                    | Confirm<br>(C) | Develop Site<br>(SD) | E+C       | E+C+<br>SD  | MW  | Confirm<br>(C) | Develop Site<br>(SD) | E+C       | E+C+<br>SD  |
| PIR00                                       | Pirouette Mountain            | (S.Dixie Valley)               | D                         | 0 / 0                    | \$1,182                 | 16                                    | \$5,048        | \$44,570             | \$6,230   | \$50,800    | 23  | \$7,556        | \$61,241             | \$8,738   | \$69,979    |
| SIL00                                       | Silver Peak                   | (Alum prospect)                | C                         | 0 / 0                    | \$36                    | 41                                    | \$12,495       | \$112,925            | \$12,531  | \$125,456   | 78  | \$24,882       | \$207,508            | \$24,918  | \$232,426   |
| SOH00                                       | Sou Hot Springs               | (Seven Devils/Gilbert's H.S.)  | D                         | 0 / 0                    | \$921                   | 3.3                                   | \$2,615        | \$11,121             | \$3,536   | \$14,657    | 6.1                                       | \$2,615        | \$19,435             | \$3,536   | \$22,971    |
| Area Totals :                               |                               |                                |                           | 66                       | \$4,056                 |                                       | \$115,896      | \$898,788            |           | \$1,018,740 |   | \$182,706      | \$1,521,022          |           | \$1,707,784 |
|   |                               |                                |                           | 7                        |                         | 363                                   |                |                      | \$119,952 |             | 572                                       |                |                      | \$186,762 |             |
| Area: 3 - Other NV                          |                               |                                |                           |                          |                         |                                       |                |                      |           |             |   |                |                      |           |             |
| BAL00                                       | Baltazor                      |                                | C                         | 0 / 0                    |                         | 11                                    | \$7,611        | \$41,628             | \$7,611   | \$49,239    | 16  | \$11,400       | \$64,833             | \$11,400  | \$76,233    |
| DOU00                                       | Double - Black Rk Hot Springs |                                | D                         | 0 / 0                    | \$4,392                 | 20                                    | \$12,495       | \$81,425             | \$16,887  | \$98,312    | 33  | \$22,376       | \$133,837            | \$26,768  | \$160,605   |
| MCG00                                       | McGee Mountain                | (Painted Hills)                | C                         | 0 / 0                    | \$945                   | 19                                    | \$5,048        | \$49,070             | \$5,993   | \$55,063    | 28  | \$7,556        | \$79,026             | \$8,501   | \$87,527    |
| PIN00                                       | Pinto Hot Springs             |                                | D                         | 0 / 0                    | \$1,017                 | 18                                    | \$5,048        | \$47,570             | \$6,065   | \$53,635    | 29  | \$7,556        | \$74,355             | \$8,573   | \$82,928    |
| SHO00                                       | Shoshone-Reese River          |                                | D                         | 0 / 0                    | \$873                   | 13                                    | \$5,048        | \$35,956             | \$5,921   | \$41,877    | 18  | \$5,048        | \$47,570             | \$5,921   | \$53,491    |
| WIL00                                       | Wilson Hot Springs            |                                | D                         | 0 / 0                    | \$741                   | 10                                    | \$2,249        | \$23,740             | \$2,990   | \$26,730    | 17  | \$4,317        | \$42,980             | \$5,058   | \$48,038    |
| Area Totals :                               |                               |                                |                           | 0                        | \$7,968                 |                                       | \$37,499       | \$279,389            |           | \$324,856   |   | \$58,253       | \$442,601            |           | \$508,822   |
|   |                               |                                |                           | 0                        |                         | 91                                    |                |                      | \$45,467  |             | 141                                       |                |                      | \$66,221  |             |
| Area: 4 - All other CA                      |                               |                                |                           |                          |                         |                                       |                |                      |           |             |   |                |                      |           |             |
| BRW01                                       | Brawley                       | Brawley (North Brawley)        | B                         | 0 / 20                   |                         | 88                                    | \$0            | \$228,968            | \$0       | \$228,968   | 135                                       | \$14,434       | \$341,740            | \$14,434  | \$356,174   |
| BRW02                                       | Brawley                       | East Brawley                   | B                         | 0 / 0                    | \$90                    | 85                                    | \$47,773       | \$312,340            | \$47,863  | \$360,203   | 129                                       | \$76,925       | \$464,100            | \$77,015  | \$541,115   |
| BRW03                                       | Brawley                       | South Brawley (Mesquite field) | B                         | 0 / 0                    | \$90                    | 45                                    | \$30,175       | \$179,352            | \$30,265  | \$209,617   | 62  | \$41,043       | \$244,442            | \$41,133  | \$285,575   |
| CAL00                                       | Calistoga                     |                                | C                         | 0 / 0                    |                         | 17                                    | \$7,033        | \$54,150             | \$7,033   | \$61,183    | 25  | \$9,368        | \$75,700             | \$9,368   | \$85,068    |
| COS00                                       | Coso                          | Field-wide Summary             | A                         | 280 / 0                  |                         | 246                                   | \$0            | \$0                  | \$0       | \$0         | 355                                       | \$40,606       | \$214,800            | \$40,606  | \$255,406   |
| DUN00                                       | Dunes                         |                                | C                         | 0 / 0                    | \$834                   | 7.4                                   | \$3,310        | \$24,325             | \$4,144   | \$28,469    | 11  | \$6,437        | \$37,660             | \$7,271   | \$44,931    |
| EAS00                                       | East Mesa                     | Field-wide summary             | A                         | 62 / 0                   |                         | 119                                   | \$43,663       | \$250,644            | \$43,663  | \$294,307   | 148                                       | \$63,105       | \$379,051            | \$63,105  | \$442,156   |

| Estimated Costs in thousands <sup>(4)</sup> |                             |                     |                           |                          |                         |                                       |                |                 |           |             |   |                |                 |           |              |
|---|-----------------------------|---------------------|---------------------------|--------------------------|-------------------------|---------------------------------------|----------------|-----------------|-----------|-------------|---|----------------|-----------------|-----------|--------------|
| PROJ ID                                     | Field or Area               | Area or Power Plant | (2)                       | (3)                      | Explor-<br>ation<br>(E) | Minimum Estimated Generation Capacity |                |                 |           |             | Most-likely Estimated Generation Capacity |                |                 |           |              |
|   |                             |                     | Explor-<br>Devel.<br>Cat. | Existing<br>Wellhd<br>MW |                         | MW                                    | Confirm<br>(C) | Develop<br>(SD) | E+C       | E+C+<br>SD  | MW  | Confirm<br>(C) | Develop<br>(SD) | E+C       | E+C+<br>SD   |
| GEY00                                       | Geysers                     | Field-wide Summary  | A                         | 850 / 0                  |                         | 1200                                  | \$269,615      | \$991,684       | \$269,615 | \$1,261,299 | 1400                                      | \$420,585      | \$1,628,424     | \$420,585 | \$2,049,009  |
| GLA00                                       | Glamis                      |                     | D                         | 0 / 0                    | \$906                   | 4.3                                   | \$4,201        | \$16,645        | \$5,107   | \$21,752    | 6.4                                       | \$4,201        | \$26,592        | \$5,107   | \$31,699     |
| HEB00                                       | Heber                       | Field-wide Summary  | A                         | 100 / 0                  |                         | 109                                   | \$1,971        | \$28,809        | \$1,971   | \$30,780    | 142                                       | \$9,317        | \$104,334       | \$9,317   | \$113,651    |
| LAK00                                       | Lake City / Surprise Valley | Lake City           | B                         | 0 / 3                    |                         | 23                                    | \$5,356        | \$67,305        | \$5,356   | \$72,661    | 37  | \$10,602       | \$105,801       | \$10,602  | \$116,403    |
| LVM00                                       | Long Valley - M-P Leases    | M-P Lease Summary   | A                         | 40 / 0                   | \$2,472                 | 70                                    | \$3,366        | \$11,557        | \$5,838   | \$17,395    | 111                                       | \$8,782        | \$133,170       | \$11,254  | \$144,424    |
| MED01                                       | Medicine Lake               | Fourmile Hill       | B                         | 0 / 0                    |                         | 25                                    | \$7,013        | \$60,604        | \$7,013   | \$67,617    | 36  | \$10,503       | \$85,768        | \$10,503  | \$96,271     |
| MED02                                       | Medicine Lake               | Telephone Flat      | B                         | 0 / 15                   |                         | 110                                   | \$9,222        | \$230,702       | \$9,222   | \$239,924   | 175                                       | \$24,390       | \$373,688       | \$24,390  | \$398,078    |
| MOS00                                       | Mount Signal                |                     | C                         | 0 / 0                    | \$441                   | 12                                    | \$2,387        | \$32,909        | \$2,828   | \$35,737    | 19  | \$4,589        | \$47,136        | \$5,030   | \$52,166     |
| NIL00                                       | Niland                      |                     | B                         | 0 / 0                    |                         | 59                                    | \$21,262       | \$165,178       | \$21,262  | \$186,440   | 76  | \$29,234       | \$217,706       | \$29,234  | \$246,940    |
| RAN00                                       | Randsburg                   |                     | C                         | 0 / 0                    | \$450                   | 32                                    | \$7,783        | \$79,820        | \$8,233   | \$88,053    | 48  | \$11,696       | \$113,366       | \$12,146  | \$125,512    |
| SAL00                                       | Salton Sea                  | Field-wide summary  | A                         | 350 / 0                  |                         | 1350                                  | \$136,065      | \$2,125,089     | \$136,065 | \$2,261,154 | 1750                                      | \$182,281      | \$2,967,552     | \$182,281 | \$3,149,833  |
| SES00                                       | Sespe Hot Springs           |                     | D                         | 0 / 0                    | \$945                   | 3.6                                   | \$2,615        | \$15,685        | \$3,560   | \$19,245    | 5.3                                       | \$2,615        | \$18,235        | \$3,560   | \$21,795     |
| SUL00                                       | Sulphur Bank                | Clear Lake          | B                         | 0 / 0                    |                         | 27                                    | \$4,517        | \$56,997        | \$4,517   | \$61,514    | 43  | \$8,929        | \$91,995        | \$8,929   | \$100,924    |
| SUP00                                       | Superstition Mountain       |                     | D                         | 0 / 0                    | \$849                   | 5.9                                   | \$2,615        | \$15,021        | \$3,464   | \$18,485    | 9.5                                       | \$5,123        | \$24,535        | \$5,972   | \$30,507     |
| Area Totals :                               |                             |                     |                           | 1682                     | \$7,077                 |                                       | \$609,942      | \$4,947,784     |           | \$5,564,803 |   | \$984,765      | \$7,695,796     |           | \$8,687,638  |
|   |                             |                     |                           | 38                       |                         | 3,638                                 |                |                 |           | \$617,019   | 4,723                                     |                |                 |           | \$991,842    |
| Grand Totals :                              |                             |                     |                           | 1878                     | \$27,785                |                                       | \$905,592      | \$7,322,259     |           | \$8,255,636 |   | \$1,438,878    | \$11,466,890    |           | \$12,933,553 |
|   |                             |                     |                           | 61                       |                         | 4,644                                 |                |                 |           | \$933,377   | 6,223                                     |                |                 |           | \$1,466,663  |

|            |               |                        | Estimated Costs in thousands <sup>(4)</sup> |                                 |                         |  |      |     |            |    |  |                 |      |     |            |
|------------|---------------|------------------------|---|---------------------------------|-------------------------|--|------|-----|------------|----|--|-----------------|------|-----|------------|
| PROJ<br>ID | Field or Area | Area or<br>Power Plant | (2)<br>Explor-<br>Devel.<br>Cat.            | (3)<br>Existing<br>Wellhd<br>MW | Explor-<br>ation<br>(E) | <u>Minimum Estimated Generation Capacity</u> |      |     |            |    | <u>Most-likely Estimated Generation Capacity</u> |                 |      |     |            |
|            |               |                        | MW  | Confirm<br>(C)                  |                         | Develop<br>(SD)                              | Site | E+C | E+C+<br>SD | MW | Confirm<br>(C)                                   | Develop<br>(SD) | Site | E+C | E+C+<br>SD |

1. The methodologies used for cost estimation are described in Appendices IV, V and VI

2. Exploration-Development Category

A = existing power plant operating

B = one or more wells tested at  $\geq 1$  MW

C = a temperature  $\geq 212^{\circ}\text{F}$  has been logged downhole (or boiling temperature for local elevation)

D = other exploration data (such as spring chemistry and/or shallow temperature gradient measurements)

3. The number to the left is actual generation and the number to the right is MW proven at the wellhead but not in use. Details are given in Table 9 (Comments to the Cost Estimates). Actual generation values are often uncertain by at least a few percent, because published records differ in detail, and often do not specify gross or net MW. Gross MW is represented whenever available.

4. Estimates represent the costs to bring each resource to the total Estimated Generation Capacity from existing (year 2003) levels of actual generation and/or MW proven but unused at the wellhead. Site Development represents the wellfield and power plant, but not the transmission line.



**Hetch Hetchy/SFPUC Programmatic Renewable Energy Project**  
**Project: 1.3 New Geothermal Site Identification and Qualification**  
**Project Team: GeothermEx, Inc.**  
**Task: 1.3.10 Final Project Report**  
**Subject: D.1.3.10.3 Final Report**

***Table 9. Comments on Confirmation Cost Estimates***

| <b><i>PROJID</i></b>                             | <b><i>Comment for Minimum Generation Estimate</i></b>  | <b><i>Comment for Mlk (Modal) Generation Estimate</i></b>   |
|--|--|---|
| <b><i>Area: 1 - Greater Reno (NV and CA)</i></b> |  |   |
| BEO00  |  |   |
| BLU00  | The generation capacity estimate assumes a default value for reservoir thickness that results in an estimated average TD/well (5000 ft) that is more than twice the depth of ID Slim hole Deep Blue No.1. Since that well has encountered some possibility of commercial production from about 2000-2500 ft. (being tested during 2003), the expected cost/well that is listed here may be too large by a factor of about 2. Conversely, the temperature at Deep Blue No.1 (BHT 291°F) is less than the Mlk average temperature used for the generation capacity estimate, and the expected capacity/well at 291°F would be 2.4 MW, not 3.4 MW. At 2.4MW/well, the expected number of wells needed to be drilled for confirmation remains 2, but it becomes increasingly likely that that a lending institution would require 2 successful full-diameter wells at adequate spacing for long-term production, plus one injector (which could possibly be Deep Blue No.1), even if the first full-diameter hole is successful. In such a case, it may be necessary to drill 3 full-diameter holes (with one dry). Given these considerations (lesser depth but lower temperature), the cost factor for drilling is here adjusted to 0.7. | See comments concerning the confirmation estimate for Min Estimated Generation Capacity.  |
| BRA00  | MW currently being produced exceeds this estimate. No further confirmation applies.  | This estimate represents confirmation to bring generation from the level actually produced in yr 2000 up to the modal estimated capacity, which is less than actual installed gross generating capacity. Current average production is about 2.1 MWgr/well (7 wells producing 15 MWgr), which means that 2 wells could be needed to confirm 1.0 MW if the first well is not successful. |

**PROJID**     *Comment for Minimum Generation Estimate*

*Comment for Mlk (Modal) Generation Estimate*

COL00     The testing of a successful deep hole would require injection capacity that might be provided by the ID Slim holes drilled during exploration. Otherwise, a second full-diameter hole may be needed.

DES00

EMP00     Existing generation exceeds the Min Estimated Capacity.

FAL00

FLY00     Deep drilling has discovered a temperature of only 211°F at 5,000 ft depth and chemical evidence of possibly higher temperatures is ambiguous. Therefore, further exploration and deep drilling may not easily attract commercial interest.

FLY01

GER00

HAZ00     Assumes drilling for a resource deeper and hotter than the confirmed production of 275°F(?) water from about 800 ft. See comments at generation capacity estimates.

     A financial institution may require a second well as additional confirmation and/or as injection capacity.

     Drilling cost factor is adjusted for the possibility of relatively rapid penetration through sediments in the upper several thousand feet, based on the section at the Magma/Dow hole (TD 3668 ft) 1.5 miles to the SW. However, basement may be shallower at the confirmation

The operator may be investigating or undertaking plant modifications designed to increase efficiency and restore generation without (some of) this additional drilling. No new field-wide testing is likely to be needed, since the normal operations of the field would provide the data collection needed to evaluate the effects of the new well(s) on the reservoir.

The testing of a successful deep hole would require injection capacity that might be provided by the ID Slim holes drilled during exploration. Otherwise, a second full-diameter hole may be needed.

Would require drilling deeper in the central zone than previously done, or stepping out to the east. Existing wellhead productivity is about 1.6 MW/well (4.8 MW/3 production wells). No compensation for the higher Expect/well (2.6 MW) is made, because somewhat deeper and more productive wells are assumed. (In addition, at 1.6 MW/well, Expect-to-drill remains 1 well at success rate 0.6.)

Deep drilling has discovered a temperature of only 211°F at 5,000 ft depth and chemical evidence of possibly higher temperatures is ambiguous. Therefore, further exploration and deep drilling may not easily attract commercial interest.

See comments at confirmation costs for Min capacity estimate.

| <i>PROJID</i> | <i>Comment for Minimum Generation Estimate</i>   | <i>Comment for Mlk (Modal) Generation Estimate</i>   |
|---------------|--|--|
|               | hole locations (which will depend upon the results of exploration.).   |  |
| HON00         |  |  |
| KYL00         |  |  |
| LEA00         | Risk of a relatively high cost per MW.   | Risk of a relatively high cost per MW.   |
| LEE00         | A lending institution may require a second confirmation hole, or the use of an ID Slim hole for injection.   | A lending institution may require a second confirmation hole, or the use of an ID Slim hole for injection. |
| NEW00         |  |  |
| NOR00         |  |  |
| PUM00         | <p>MW unused represents production at 219°F from the Tipton No.1 well, although flow rate is unknown. A developer would probably need to pump the well, but it is unknown whether the existing well completion would permit this.</p> <p>A lending institution may require a second confirmation well for injection and/or backup capacity, which would double the confirmation cost. The Tipton No.1 well might be available for this use.</p> <p>The capacity estimation (and this confirmation estimate) assumes that permeability can be found beneath the 219°F zone at c.3,000 ft that was found by Tipton No.1, and at a higher temperature.</p> <p>The target of confirmation and development could be instead the zone at c.3,000 ft/219°F. In such a case: a) estimated resource capacity decreases, as described under Comments to Generation Capacity; b) per-well expected capacity becomes c.0.9 MW; c) drilling cost per well is lowered by about 1/2, and; d) expect-to-drill increases to 2 wells. Therefore, estimated confirmation cost remains about the same.</p> | See Comments under Confirmation Costs - Min.   |
| PYR00         | <p>The development target is a deeper and hotter resource than found by the Western Geothermal holes, the presence of which is suggested by geothermometry.</p> <p>It is assumed that the Western Geothermal holes are not suitable or no longer available for commercial use.</p> <p>If the confirmation/development target is instead the known</p>  | See Comments at Confirmation Costs - Min.  |

***PROJID      Comment for Minimum Generation Estimate***

***Comment for Mlk (Modal) Generation Estimate***

permeability in the Western Geothermal holes (c.4,000 - 5,800 ft, 240°F), then Expect/well becomes 1.3 MW, drilling costs drop somewhat, but Expect-to-drill increases to 2 wells.

RYE01      MW unused is uncertain: it is reported that there are 6 wells that are definitely commercial to marginally commercial (see Well Summaries), and it is assumed that 3 of these produce 3.4 MW each.

Confirmation for a 16 MW development is therefore regarded as achieved. However, there is good evidence that historic confirmation drilling at Rye Patch has found it difficult to find commercial permeability, except for moderate-temperature (c.260-340°F) water from relatively shallow zones, and in spite of the success of one deep well in finding a commercial flow of 405°F water. Given this fact, additional confirmation drilling may be demanded for development beyond 10 MW.

RYE02

SAW00

SOD00      MW in use is approximate, calculated as the ratio of gross MW installed to net MW installed, times net MW produced during 2000 ( $(26.1/16.6)*10 = 15.7$ ).

Historic productivity per well appears to be closer to 3.1MW than 3.7 MW (see data under Well Summaries), but Expect-to-drill remains unchanged.

STE00      An increase to Min. Estimated Capacity from actual production would probably require only one new production well at an expected high success rate. Therefore, the cost is assigned only to Development, and Confirmation is assumed to be 0.

There is good evidence that historic confirmation drilling at Rye Patch has found it difficult to find commercial permeability, except for moderate-temperature (c.260-340°F) water from relatively shallow zones, and in spite of the success of one deep well in finding a commercial flow of 405°F water.

Given this difficulty, it seems unlikely that the current developer will seek to develop the Modal Estimated Capacity, without first successfully developing and producing (close to) the Min Estimated Capacity, even though confirmation for development of the modal estimated capacity has otherwise already been obtained.

See comments at Confirmation Costs - MIn.

Drilling and well test cost factors have been adjusted to 1.2 because the historic productivity per well appears to be closer to 3.1 than 3.7 (see data under Well Summaries), which changes Expect to drill to 5 wells.

It is apparent that developer/operators of this field have found it difficult to achieve and maintain production equal to installed capacity. Therefore, it is unlikely that an attempt to increase production to the Modal Estimated Capacity would be made, until and unless sustained production at the Min Estimated Capacity level can be demonstrated.

Very high permeability has made it possible to produce from relatively shallow wells, about 1,000 ft deep in the northern part of the field (Lower Steamboat) and 3,100 ft deep in the southern part of the field (Upper Steamboat), so the Expected TD/well (which is calculated from estimated average depth to top of reservoir and average reservoir thickness) is unrealistically high. Drilling cost

***PROJID      Comment for Minimum Generation Estimate***

STI00            MW in use is approximate, calculated as the ratio of gross MW installed to net MW installed, times net MW produced during 2000 ((19/10)\*7.5 = 14.3). This total exceeds Min Estimated Capacity, so a confirmation estimate does not apply.

STI01            MW unused is an approximate value, estimated from the reported results of 3 full-diameter holes (see Well Summaries); it indicates that confirmation has been achieved.

TRI00

WAB00            Assumes drilling to greater depth than currently being produced (c.2,200 ft), in search of the higher temperatures indicated by chemical geothermometers. It is unknown whether quantitative studies have been done to determine whether long-term production from c.2,200 ft could be expanded (and it is also unknown whether such studies could be conducted without additional testing and data gathering). Possibly high cost for the expected MW/well.

***Area: 2 - NV with direct access to CA***

AUR00

DIX00

***Comment for MLk (Modal) Generation Estimate***

factor has been adjusted to reflect an average depth of 2,000 ft.

MW in use is approximate, calculated as the ratio of gross MW installed to net MW installed, times net MW produced during 2000 ((19/10)\*7.5 = 14.3).

Existing production does not match installed capacity, and the 4.7 MW shortfall suggests that the developer/operator has found it difficult to achieve or maintain the installed production level (which is equal to the Modal Estimated Capacity) using wells in the immediate lease area. The owner/developer of Stillwater Geothermal 1 also owns/controls the Stillwater North Expansion project (project STI01), and it is considered probable that the additional 4.7 MW will be sought in the Stillwater North Expansion area (project STI01). Therefore, confirmation for additional MW production in Stillwater Geothermal 1 is set to 0.

MW unused is an approximate value, estimated from the reported results of 3 full-diameter holes (see Well Summaries). Drilling cost factor is adjusted to reflect evidence that successful production is achieved with wells that are about 2,500 ft deep.

See comments at Confirmation Costs - Min. Possibly high cost for the expected MW/well.

It is very doubtful that the operator will attempt to increase power generation by this amount, unless significant new step-out opportunities were to be discovered.

Drilling and testing cost factor are adjusted for the historic average of 9.4 MW/well, which reduces Expect-to-drill to 2.57 wells.

| <i><b>PROJID</b></i>                 | <i><b>Comment for Minimum Generation Estimate</b></i>   | <i><b>Comment for Mlk (Modal) Generation Estimate</b></i>  |
|--------------------------------------|---|--|
| DIX01                                | Existing evidence points to a large volume of very hot rock, but commercial levels of permeability have yet to be established.  | Existing evidence points to a large volume of very hot rock, but commercial levels of permeability have yet to be established. |
| EMI00                                |   |  |
| FIS00                                | It is assumed that the two existing holes that are said to be commercial producers have a gross capacity each of 3.7 MW.  | It is assumed that the two existing holes that are said to be commercial producers have a gross capacity each of 3.7 MW.       |
| HAW00                                |   |  |
| HYD00                                | Risk of high cost per MW.   | Risk of high cost per MW.  |
| PIR00                                |   |  |
| SIL00                                |   |  |
| SOH00                                | High cost relative to expected MW/well.   |  |
| <i><b>Area: 3 - Other NV</b></i>     |   |  |
| BAL00                                | Injection capacity would have to be proven and used for testing. If the deep hole or ID Slim holes previously drilled have been plugged and abandoned, a second hole, for injection, may be needed.   |  |
| DOU00                                | Expected capacity/well is low, due to a most-likely temperature of only c.250°F. Expected TD/well is a default value due to lack of data. Confirmation expenses will probably not be warranted unless further exploration increases the likelihood of a higher resource temperature, or relatively shallow permeability is encountered. | See comment at cost of confirming Min Capacity Estimate.   |
| MCG00                                |   |  |
| PIN00                                |   |  |
| SHO00                                |   |  |
| WIL00                                | It is unlikely that a financial institution would except confirmation without a second well. An ID Slim hole (included in Exploration Cost Estimate) might be acceptable, particularly if usable for injection.   |  |
| <i><b>Area: 4 - All other CA</b></i> |   |  |
| BRW01                                | Confirmation already achieved (see comments at Confirmation   | A 10-MW power plant operated from 1980-85. It is reasonably likely   |

**PROJID**      **Comment for Minimum Generation Estimate**

Costs - Mlk )

**Comment for Mlk (Modal) Generation Estimate**

that the closure of operations in 1985 had more to do with the power plant and the cost of corrosion and scale control, than with a limitation of the resource. As of 1985, the Salton Sea resource would have been more attractive to Unocal as a priority for development, due to higher temperature, shallower depth and lower gas content.

Rig test data (Figure BRW01-1) suggest that wells Veysey 7RD, 8, 12 and 15 had a combined TMF of about 1900 klb/hr at commercial WHP. At about 20% steam fraction (380 klb/hr steam) and 20 klb steam/MW, this would confirm about 20 MW. Longer-term test data are not available.

It is therefore assumed that 20 MW have been confirmed, and the cost estimate here represents drilling to confirm an expansion to the full minimum estimated capacity. However, the apparently successful older wells may no longer be available or suitable for a new development, and may have to be re-drilled (whether they have been plugged and abandoned has not been researched).

It is reported that the 10-MW power plant operated using 2 production wells. If so, the average production was 5 MW/well, which would change Expect-to-drill to  $1.67 = 2$  wells at the success ratio of 0.6. It is assumed that there is enough information about the resource available in private hands that the success ratio will be higher, and it will be necessary to drill only one new well.

Other Cost represents the approximate cost of corrosion-resistant titanium casing in two wells at \$2.5 million each.

BRW02      Available information (e.g. data on Figure BRW02-2) indicates that exploration wells Emanuelli 1 and Borchard A-1 had a combined capacity of about 220 klb/hr steam at commercial WHP, which would have confirmed about 11 MW. However, without evidence from longer-term tests, it is considered unlikely that a lending institution would accept these wells (probably since abandoned) as confirmation of the resource.

Other Cost represents the assumption that corrosion-resistant titanium casing would be needed in 3 wells (\$2,500,000 each). The salinity of this resource is apparently somewhat lower than at the Salton Sea field (about 16 wt.% instead of 25 wt.%).

See comments under Min Capacity Estimate. Other Cost represents the use of corrosion-resistant titanium casing in 5 wells at \$2.5million/well.

BRW03      Data tabulated in Figure BRW03-1 indicate that tests of Mercer 1-28

See Comments under Min Capacity Estimate. Other Cost represents

***PROJID      Comment for Minimum Generation Estimate***

***Comment for Mlk (Modal) Generation Estimate***

and 2-28 and Lacy 1A-28 and 2-28 produced a total steam flow at commercial WHP of about 275 klb/hr. This would yield about 14 MW, which is enough for confirmation.

Mercer 1-28 and Lacy 2-28 contributed only about 2.5 MW of the 14 MW total. These two wells would be considered non-commercial and suitable only for injection, considering the well depth and completion cost for a hyper-saline brine resource.

It is assumed that a commercial lender would require at least one new well to be successfully drilled and tested before committing to development, so the MW already confirmed (MW unused) is set to zero instead of 14. If the existing wells are no longer available, then it could be necessary to drill two successful new wells, to provide one for injection, before confirmation can be confirmed. Therefore, Expect-to-drill = 3 wells is considered reasonable.

Other Cost represents the use of corrosion-resistant titanium casing in two wells.

the use of corrosion-resistant titanium casing in 3 wells.

CAL00      Confirmation expenses may not be warranted, due to environmental sensitivity and existing development of the area.

Confirmation expenses may not be warranted, due to environmental sensitivity and existing development of the area.

COS00      Min Estimated Capacity is less than actual production. No confirmation estimate is required.

The operator is unlikely to attempt expansion of the Coso field to this extent, unless there is a discovery of significant new productive territory outside of the presently confirmed area of the reservoir as shown by the 350°F contour on Figure COS00-1. The "Northeast Frontier" (project COS04) may be such an area, but apparently not yet confirmed by drilling.

Drilling and well test cost factors are adjusted to reflect a historic average productivity of 3.3 MW/well.

DUN00      A lending institution would probably require a second well, drilled either as a producer available for injection, or solely for injection.

EAS00      MW in use is the 49.7 MW produced at the Ormesa plants, plus an assumed 12 MW produced at the GEM plants for pumping the Ormesa wells (If all 35 production wells require about 1/3 MW each, then the power requirement is about 12 MW).

MW in use is the 49.7 MW produced at the Ormesa plants, plus an assumed 12 MW produced at the GEM plants for pumping the Ormesa wells (If all 35 production wells require about 1/3 MW each, then the power requirement is about 12 MW).

Existing production of about 62 MW from 35 wells amounts to 1.9

Existing production of about 62 MW from 35 wells amounts to 1.9

***PROJID      Comment for Minimum Generation Estimate***

***Comment for Mlk (Modal) Generation Estimate***

|       |   |  |
|-------|---|--|
|       | MWgr/well. The Drilling and Well Test Cost Factors are adjusted to compensate for the inaccurate 2.7 MWgr/well value that is based on temperature alone.  | MWgr/well. The Drilling and Well Test Cost Factors are adjusted to compensate for the inaccurate 2.7 MWgr/well value that is based on temperature alone.   |
|       | Given historic production at less than installed capacity, it is unlikely that the Operator/Developer will attempt an expansion of this field to the full Min (90% probable) Estimated Capacity value.  | Given historic production at less than installed capacity, it is unlikely that the Operator/Developer will attempt an expansion of this field to the Mlk (Modal) Estimated Capacity value.   |
| GEY00 | <p>Due to a wide range of depths to top of reservoir in this field, the expected TD/well 9500 ft. is regarded as too large. Drilling cost factor is adjusted to compensate, assuming an average depth of 7,500 ft. Drilling factor is also adjusted to compensate for a real historic average of 2 MW/well.</p> <p>Since this is a producing steam field, well test costs are small, and a field test is regarded as unnecessary.</p> <p>Until about 2001 or 2002, there was some unused wellhead capacity in the abandoned CCPA project area at the northeast end of the steamfield. It is understood that all of these wells have been abandoned, but this has not been confirmed. A small amount of unused wellhead capacity may still exist in the abandoned Bottle Rock project area, along the eastern edge of the field south of the CCPA area, but all of these wells may also have been abandoned.</p> | See comments at Min Capacity Estimate.   |
| GLA00 | The reported depth to top of reservoir (basis unknown) results in an estimated depth/well which is considered unrealistic. Drilling cost factor is reduced to reflect a depth of 8,000 ft.  | See comment at confirmation costs for Min.Generation Estimate.   |
| HEB00 | <p>Relationships between installed capacity and number of production wells suggest that the average/well is about 4.3 MWgr. Drilling and well test cost factors are adjusted to compensate.</p> <p>MW total installed gross capacity is assumed to be MW in use.</p>  | <p>Relationships between installed capacity and number of production wells suggest that the average/well is about 4.3 MWgr. Drilling and well test cost factors are adjusted to compensate.</p> <p>MW total installed gross capacity is assumed to be MW in use.</p> |
| LAK00 | MW unused represents Phipps 2, which is assumed to be available. If not, Expect-to-drill increases to 3 wells.  | MW unused represents Phipps 2, which is assumed to be available. If not, Expect-to-drill increases to 5 wells.   |
| LVM00 | Well depth is likely to increase from E to W. The expected average depth listed here (calculated from estimated depth to top of reservoir and estimated thickness) is regarded as somewhat high, and expected   | Well depth is likely to increase from E to W. The expected average depth listed here (calculated from estimated depth to top of reservoir and estimated thickness) is regarded as somewhat high, and expected  |

| <i><b>PROJID</b></i> | <i><b>Comment for Minimum Generation Estimate</b></i>   | <i><b>Comment for Mlk (Modal) Generation Estimate</b></i>   |
|----------------------|---|---|
|                      | MW/well is somewhat low (production wells in the Casa Diablo field average 5 MW each), so drilling and well test cost factors are adjusted to compensate.   | MW/well is somewhat low (production wells in the Casa Diablo field average 5 MW each), so drilling and well test cost factors are adjusted to compensate. |
| MED01                | Some MW capacity at the wellhead may have already been confirmed, but data are not available.   | Some MW capacity at the wellhead may have already been confirmed, but data are not available.   |
| MED02                | MW confirmed represents the three commercially successful wells that already have been drilled. The developer is apparently planning on about 10 production wells (Figure MED02-1) for a 49.5 MW plant, which would be 5 MW/well. MW unused represents the three commercially successful wells that already have been drilled.  | See Comments at Confirmation Cost - Min.  |
| MOS00                | The nominal expected TD/well (4,450 ft) is less than the 5,230 ft depth at which the 2.5°F/100 ft gradient in the 1,826 ft Phillips hole projects to the Mlk average temperature of 345°F. An estimated depth of 5,230 ft is regarded as more realistic than 4,450 ft, so drilling cost factor is adjusted to 1.2 to compensate.<br><br>A lending institution is likely to require a second well, at least to enable injection during testing. It is assumed that a second ID Slim hole drilled in the exploration program will serve for that purpose and satisfy the lender, but this is not certain. | See comments at confirmation for Min Generation Capacity Estimate   |
| NIL00                | Drilling cost factor is adjusted to 0.8 to compensate for probable over-estimation of TD/well. Other Cost represents \$2,500,000/well for titanium casing in 2 wells.<br><br>Three wells are reported to have been successfully tested. Details are not available but this suggests that there may exist some unused wellhead capacity.   | See comment at confirmation estimate for Min Estimated generation capacity.   |
| RAN00                |   |   |
| SAL00                | MW in use is based on current production, but some excess well capacity may already exist and be available for an expansion of generation.<br><br>Drilling and well test cost factors are adjusted for the historic average 11 MWgr/well (350 MW/31 wells) and for an expected very   | See comments at confirmation cost for Min Generation Estimate.  |

| <i><b>PROJID</b></i> | <i><b>Comment for Minimum Generation Estimate</b></i>   | <i><b>Comment for MLk (Modal) Generation Estimate</b></i>                                  |
|----------------------|---|--|
|                      | low dry- hole fraction (10%). It is also assumed that depth/well has been over-estimated.<br>Other cost represents titanium casing in 10 wells at \$2,500,000/well.   |  |
| SES00                | A lending institution may require a second well, to confirm temperature and permeability and allow testing with injection. An ID Slim hole drilled during exploration might be acceptable for this purpose. The remote location and apparent environmental sensitivity of this are make confirmation and development uncertain. | See comments at Confirmation Costs - Min.  |
| SUL00                |   |  |
| SUP00                | A lender is likely to require a second well. A permeable ID Slim hole drilled during exploration may serve for this.  | Drilling cost factor is 2 on the assumption that a lender will require a second deep well. |



**Hetch Hetchy/SFPUC Programmatic Renewable Energy Project**  
**Project: 1.3 New Geothermal Site Identification and Qualification**  
**Project Team: GeothermEx, Inc.**  
**Task: 1.3.10 Final Project Report**  
**Subject: D.1.3.10.3 Final Report**

***Table 10. Comments on Site Development Cost Estimates***

| <b><i>PROJID</i></b>                             | <b><i>Comment for Minimum Generation Estimate</i></b>   | <b><i>Comment for Mlk (Modal) Generation Estimate</i></b>   |
|--|---|---|
| <b><i>Area: 1 - Greater Reno (NV and CA)</i></b> |   |   |
| BEO00  | I/P and P+I success rate are adjusted to estimated historic Beowawe levels.   | I/P and P+I success rate are adjusted to estimated historic Beowawe levels.   |
| BLU00  | Cost Factor for development drilling is adjusted to reflect a well depth of 2,500 ft and wellhead capacity 2.4 MW/well (see comments at confirmation cost estimate).  | Cost Factor for development drilling is adjusted to reflect a well depth of 2,500 ft and wellhead capacity 2.4 MW/well (see comments at confirmation cost estimate).  |
| BRA00  | MW currently being produced exceeds this estimate. No development applies.  | At 2.1 MWgr/well current average wellhead productivity, 2 production wells would be needed for the wellhead development plan, instead of the 1 well calculated at 3.7MW/well. It is assumed that a previously drilled successful confirmation well will combine with the 1 development well to provide the total 4 MW needed. |
| COL00  |   |   |
| DES00  | I/P and P+I success rate are adjusted to historic values.   | I/P and P+I success rate are adjusted to historic values.   |
| EMP00  | Existing generation exceeds the Min Estimated Capacity, no development applies.   | I/P and P+I success rate are adjusted to estimated historic values. Existing wellhead productivity is about 1.6 MW/well (4.8 MW/3 production wells). No compensation of the Cost Factor for development drilling is made, because somewhat deeper, more productive wells are assumed.   |
| FAL00  |   |   |
| FLY00  | Deep drilling has discovered a temperature of only 211°F at 5,000 ft depth and chemical evidence of possibly higher temperatures is ambiguous. Therefore, further exploration and deep drilling may not easily attract commercial interest. | Deep drilling has discovered a temperature of only 211°F at 5,000 ft depth and chemical evidence of possibly higher temperatures is ambiguous. Therefore, further exploration and deep drilling may not easily attract commercial interest.   |

| <i>PROJID</i> | <i>Comment for Minimum Generation Estimate</i>  | <i>Comment for Mlk (Modal) Generation Estimate</i>  |
|---------------|---|---|
| FLY01         |   |   |
| GER00         |   |   |
| HAZ00         | Drilling cost factor is adjusted for the possibility of relatively rapid penetration through sediments in the upper several thousand feet, based on the section at the Magma/Dow hole (TD 3668 ft) 1.5 miles to the SW.   | Drilling cost factor is adjusted for the possibility of relatively rapid penetration through sediments in the upper several thousand feet, based on the section at the Magma/Dow hole (TD 3668 ft) 1.5 miles to the SW. |
| HON00         |   |   |
| KYL00         |   |   |
| LEA00         | Risk of a relatively high cost per MW.  | Risk of a relatively high cost per MW.  |
| LEE00         |   |   |
| NEW00         |   |   |
| NOR00         |   |   |
| PUM00         | See comments at Confirmation costs - MIn  | See comments at Confirmation costs - MIn  |
| PYR00         | See Comments at Confirmation Costs - Min.   | See Comments at Confirmation Costs - Min.   |
| RYE01         | <p>MW unused-at-wellhead is uncertain: it is reported that there are 6 wells that are definitely commercial to marginally commercial (see Well Summaries), and it is assumed that 3 of these produce 3.4 MW each.</p> <p>Information listed under Well Summaries suggests that the successful hole ratio for Rye Patch has been (and may remain) lower than the default value of 0.8, so a value of 0.7 is applied.</p> <p>It is assumed that the 12.5 MW binary plant constructed 1991-93 is still on-site, unused and available. Other Dev. Cost represents the assumption that this plant will be purchased by a new developer, at a 50% discount.</p> | See comments at Development Costs - Min.  |
| RYE02         |   |   |
| SAW00         |   |   |
| SOD00         | MW in use is approximate, calculated as the ratio of gross MW installed to net MW installed, times net MW produced during 2000  | See comments at Development Costs - Min.  |

**PROJID**      ***Comment for Minimum Generation Estimate***

***Comment for Mlk (Modal) Generation Estimate***

((26.1/16.6)\*10 = 15.7).

I/P and P+I success rate are adjusted to historic values.

Drilling cost factor has been adjusted to 1.2 because the historic productivity per well appears to be closer to 3.1 than 3.7 (see data under Well Summaries).

STE00      P/I and P+I success rate are adjusted to historic values. Drilling cost factor is adjusted for an average depth/well of about 2,000 ft. (See comments at Confirmation Costs - Mlk).

STI00      MW in use is approximate, calculated as the ratio of gross MW installed to net MW installed, times net MW produced during 2000 ((19/10)\*7.5 = 14.3). This total exceeds Min Estimated Capacity, so a development estimate does not apply.

STI01      MW unused is an approximate value, estimated from the reported results of 3 full diameter holes (see Well Summaries).  
P/I and P+I success rate are adjusted to historic values at STI00.  
Drilling cost factor is adjusted to reflect evidence that successful production has been achieved with wells that are about 2,500 ft deep.  
Although Existing plant capacity is 0, it is assumed that 4.7 MW of the new wellhead production developed in Stillwater North will be shipped south to Stillwater Geothermal 1 (STI00), to bring that plant up to full generation capacity, and a smaller plant will be constructed for the North Expansion. The negative other-development cost value (which represents 4.7 MW) compensates, effectively providing an assumption that the new plant will be  $14 - 4.7 = 9.3$  MW.

TRI00

P/I and P+I success rate are adjusted to historic values. Drilling cost factor is adjusted for an average depth/well of about 2,000 ft. (See comments at Confirmation Costs - Mlk).

MW in use is approximate, calculated as the ratio of gross MW installed to net MW installed, times net MW produced during 2000 ((19/10)\*7.5 = 14.3).

Existing production (MW in use) does not match installed plant capacity, and the 4.7 MW shortfall suggests that the developer/operator has found it difficult to achieve or maintain the installed production level (which is equal to the Modal Estimated Capacity) using wells in the immediate lease area. The owner/developer of Stillwater Geothermal 1 also owns/controls the Stillwater North Expansion project (project STI01), and it is considered probable that the additional 4.7 MW will be sought in the Stillwater North Expansion area (project STI01). Therefore, development for additional MW production in Stillwater Geothermal 1 is set to 0.

See comments at Development Costs - Min.

| <i>PROJID</i>                                | <i>Comment for Minimum Generation Estimate</i>  | <i>Comment for Mlk (Modal) Generation Estimate</i>  |
|--|---|---|
| WAB00  | Assumes drilling to greater depth than currently being produced (c.2,200 ft), in search of the higher temperatures indicated by chemical geothermometers. It is unknown whether quantitative studies have been done to determine whether long-term production from c.2,200 ft could be expanded (and it is also unknown whether such studies could be conducted without additional testing and data gathering). Possibly high cost for the expected MW/well.<br>P+I success rate reflects historic average. | See comments at Development Costs - Min.  |
| <i>Area: 2 - NV with direct access to CA</i> |   |   |
| AUR00  |   |   |
| DIX00  | Cost factor for drilling is adjusted for the historic average of 9.4 MW/well. I/P and P+I success rate are adjusted to historic values.   | It is very doubtful that the operator will attempt to increase power generation by this amount, unless significant new step-out opportunities were to be discovered.<br>Cost factor for drilling is adjusted for the historic average of 9.4 MW/well. I/P and P+I success rate are adjusted to historic values. |
| DIX01  | Existing evidence points to a large volume of very hot rock, but commercial levels of permeability have yet to be established.  | Existing evidence points to a large volume of very hot rock, but commercial levels of permeability have yet to be established.  |
| EMI00  |   | Transmission line costs might be lowered by combining project with development of the near-by Fish Lake project (FIS00).  |
| FIS00  | It is assumed that the two existing holes that are said to be commercial producers have a gross capacity each of 3.7 MW.  | It is assumed that the two existing holes that are said to be commercial producers have a gross capacity each of 3.7 MW.  |
| HAW00  |   |   |
| HYD00  | Risk of high cost per MW.   | Risk of high cost per MW.   |
| PIR00  |   |   |
| SIL00  |   |   |
| SOH00  |   | High cost relative to expected MW/well.   |
| <i>Area: 3 - Other NV</i>                    |   |   |
| BAL00  |   |   |
| DOU00  | Expected capacity/well is low, due to a most-likely temperature of  | Expected capacity/well is low, due to a most-likely temperature of  |

***PROJID      Comment for Minimum Generation Estimate***

only c.250°F. Expected TD/well is a default value due to lack of data. Development is unlikely unless further exploration increases the likelihood of a higher resource temperature, or relatively shallow permeability is encountered.

MCG00

PIN00

SHO00

WIL00

***Area: 4 - All other CA***

BRW01      MW unused at wellhead may be inaccurate. See comments at Confirmation Costs - Mlk. I/P during power plant operation in 1983 was 2, but historic I/P at the similar (but shallower) Salton Sea resource (SAL00) has been about 0.85. It is assumed that the higher Brawley I/P was due to availability of wells and that a lower I/P would be possible, so a value of 1 is being applied. Other cost represents the approximate cost of titanium casing in 11 wells at \$2.5 million each.

BRW02      Salton Sea historic I/P assumed. Other cost is titanium casing in production wells at \$2.5 million each.

BRW03      Development cost may be over-estimated. Unused at wellhead may be as high as 11.5, if wells drilled and tested in 1980s are available, and confirmation may have added 6.5 MW more (see comments at Confirmation Cost - Min). In such a case, the production need may be only 1 or 2 wells. Injection need may be reduced if wells drilled in 1980s can serve for injection even if no longer in condition for production. I/P of Salton Sea project (SAL00) assumed. Other cost is titanium casing in 6 production wells at \$2.5 million each.

CAL00      Development is relatively unlikely, due to environmental sensitivity and existing development of the area.

COS00      Min Estimated Capacity is less than actual production. No development estimate is required.

***Comment for Mlk (Modal) Generation Estimate***

only c.250°F. Expected TD/well is a default value due to lack of data. Development will probably not be warranted unless further exploration increases the likelihood of a higher resource temperature, or relatively shallow permeability is encountered.

See comments at Development Costs - Min.  
Other Cost represents titanium casing in the production wells at \$2.5million/well.

Salton Sea I/P assumed. Other cost is titanium casing in production wells at \$2.5 million each.

See Comments at Development Costs for Min Estimated Generation Capacity.

Development is relatively unlikely, due to environmental sensitivity and existing development of the area.

I/P and P+I success rate are adjusted to estimated historic values.  
Cost factor for development drilling is adjusted to reflect a historic

***PROJID      Comment for Minimum Generation Estimate***

***Comment for Mlk (Modal) Generation Estimate***

DUN00

EAS00      I/P and (P+I) success rate are based on historic values. Existing production of about 62 MW from 35 wells amounts to 1.9 MWgr/well. The Drilling Cost Factor is adjusted to compensate for the inaccurate 2.7 MWgr/well value that is based on temperature alone. Existing plant reflects only the Ormesa plants and does not include GEM2-3.

Given historic production at less than installed capacity, it is unlikely that the Operator/Developer will attempt an expansion of this field to the full Min (90% probable) Estimated Capacity value.

GEY00      I/P is the historic value. The overall success rate of Geysers wells is very high, but many wells require re-drills and some are completed with multiple open legs.

Drilling cost factor is adjusted to assume an average depth of 7,500 ft and a real historic average of 2 MW/well.

Existing plant is set to current generation, but there has been a considerable amount of under-utilized plant capacity due to productivity declines at existing wells. Some plant capacity has been decommissioned, but some is probably available for (re-)expansion beyond 900 MW. Therefore, Total On-site Capital Cost may be grossly over-estimated.

GLA00      The reported depth to top of reservoir (basis unknown) results in an estimated depth/well which is considered unrealistic. Drilling cost factor is reduced to reflect a depth of 8,000 ft.

HEB00      P+I success rate is the historic value. Relationships between installed capacity and number of production wells suggest that the average/well is about 4.3 MWgr. Drilling cost factors is adjusted to compensate.

LAK00

LVM00      I/P and P+I success rate are adjusted to historic values at the Casa Diablo wellfield, but the ratios at other Long Valley M-P lease

average productivity of 3.3 MW/well.

I/P and (P+I) success rate are based on historic values. Existing production of about 62 MW from 35 wells amounts to 1.9 MWgr/well. The Drilling Cost Factor is adjusted to compensate for the inaccurate 2.7 MWgr/well value that is based on temperature alone. Existing plant reflects only the Ormesa plants and does not include GEM2-3.

Given historic production at less than installed capacity, it is unlikely that the Operator/Developer will attempt an expansion of this field to the Mlk (Modal) Estimated Capacity value.

See comments at Development Costs - Mlk

The reported depth to top of reservoir (basis unknown) results in an estimated depth/well which is considered unrealistic. Drilling cost factor is reduced to reflect a depth of 8,000 ft.

P+I success rate is the historic value. Relationships between installed capacity and number of production wells suggest that the average/well is about 4.3 MWgr. Drilling cost factors is adjusted to compensate.

I/P and P+I success rate are adjusted to historic values at the Casa Diablo wellfield, but the ratios at other Long Valley M-P lease

| <i>PROJID</i> | <i>Comment for Minimum Generation Estimate</i>   | <i>Comment for Mlk (Modal) Generation Estimate</i>   |
|---------------|--|--|
|               | locations could be quite different. See comments at Mlk confirmation cost estimate with respect to the cost factor for drilling.   | locations could be quite different. See comments at Mlk confirmation cost estimate with respect to the cost factor for drilling. |
| MED01         | I/P and P+I success rate are based on Telephone Flat data (MED02)  | I/P and P+I success rate are based on Telephone Flat data (MED02)  |
| MED02         | The development plan wellfield (Figure MED02-1) shows 10 P wells, 4 I wells, and 3 wells that are I/P (assumed to be I or P depending upon drilling outcomes). If the I/P wells are split, then 11.5 P and 5.5 I yields I/P ratio = 0.5. Drilling to date has had a success rate of about 0.75, and it is assumed that this will improve to the default value of 0.8 | See comments at Development Costs for Min Estimated Generation Capacity.   |
| MOS00         | see comments at Confirmation Costs - Min   | see comments at Confirmation Costs - Min   |
| NIL00         | I/P is the historic Salton Sea project value.  | see comments at Development Costs - Min  |
|               | Drilling cost factor is adjusted to 0.8 to compensate for probable over-estimation of TD/well. Other Cost represents \$2,500,000/production well for titanium casing.  |  |
|               | Three wells are reported to have been successfully tested. Details are not available but this suggests that there may exist some unused wellhead capacity.   |  |
| RAN00         |  |  |
| SAL00         | I/P and P+I success rate are historic values.<br>Drilling cost factor is adjusted for the historic average 11 MWgr/well (350 MW/31 wells) and for an expected very low dry hole fraction (10%). It is also assumed that depth/well has been over-estimated. Other cost is titanium casing at \$2,500,000/production well.  | See comments at Development Costs - Min.   |
| SES00         |  |  |
| SUL00         |  |  |
| SUP00         |  |  |



**Hetch Hetchy/SFPUC Programmatic Renewable Energy Project**  
**Project: 1.3 New Geothermal Site Identification and Qualification**  
**Project Team: GeothermEx, Inc.**  
**Task: 1.3.10 Final Project Report**  
**Subject: D.1.3.10.3 Final Report**

**Table 11. Confirmation and Site Development Cost Estimates - Drilling Details<sup>(1)</sup>**

| PROJ<br>ID                         | Field or Area        | Area or<br>Power Plant | Explor.-<br>Devel.<br>Cat. | Estimated<br>Generation | (4)<br>Existing<br>Wellhd<br>MW | (5)<br>Est.<br>MW<br>/well | (6)<br>Expect<br>TD<br>/well<br>(ft) | (7)<br>Confirmation            |      |      |                | (8)<br>Development            |              |      |             |                 |                | Total<br>Drilling<br>(\$1000) |
|------------------------------------|----------------------|------------------------|----------------------------|-------------------------|---------------------------------|----------------------------|--------------------------------------|--------------------------------|------|------|----------------|-------------------------------|--------------|------|-------------|-----------------|----------------|-------------------------------|
|                                    |                      |                        |                            | (2) Capacity(MW)        |                                 |                            |                                      | (3) Upper = Min<br>Lower = Mlk | Plan | Plan | Cost-<br>Fact. | Total<br>Drilling<br>(\$1000) | Plan<br>(MW) | I/P  | (P+I)<br>/T | Plan<br>(wells) | Cost-<br>Fact. |                               |
|                                    |                      |                        |                            |                         |                                 |                            |                                      |                                |      |      |                |                               |              |      |             |                 |                |                               |
| Area: 1 - Greater Reno (NV and CA) |                      |                        |                            |                         |                                 |                            |                                      |                                |      |      |                |                               |              |      |             |                 |                |                               |
| BEO00                              | Beowawe              |                        | A                          | 30                      | 15 /0                           | 4.7                        | 9,600                                | 3.8                            | 1    | 1.00 | \$4,014        | 12.75                         | 0.33         | 0.60 | 7           | 1.0             | \$28,098       |                               |
| BEO00                              | Beowawe              |                        | A                          | 41                      | 15 /0                           | 4.7                        | 9,600                                | 6.5                            | 2    | 1.00 | \$8,028        | 21.55                         | 0.33         | 0.60 | 12          | 1.0             | \$48,168       |                               |
| BLU00                              | Blue Mountain        |                        | C                          | 16                      | 0 /0                            | 3.4                        | 5,000                                | 4.0                            | 2    | 0.70 | \$2,475        | 12.8                          | 0.95         | 0.80 | 10          | 0.7             | \$12,376       |                               |
| BLU00                              | Blue Mountain        |                        | C                          | 30                      | 0 /0                            | 3.4                        | 5,000                                | 7.5                            | 4    | 0.70 | \$4,950        | 24                            | 0.95         | 0.80 | 18          | 0.7             | \$22,277       |                               |
| BRA00                              | Brady's Hot Springs  |                        | A                          | 11                      | 15 /0                           | 3.7                        | 6,500                                | 0.0                            | 0    | 0.00 | \$0            | -3.45                         | 0.95         | 0.80 | 0           | 0.0             | \$0            |                               |
| BRA00                              | Brady's Hot Springs  |                        | A                          | 18                      | 15 /0                           | 3.7                        | 6,500                                | 0.8                            | 1    | 1.00 | \$2,411        | 3.15                          | 1.30         | 0.80 | 3           | 1.0             | \$7,233        |                               |
| COL00                              | Colado               |                        | C                          | 3.7                     | 0 /0                            | 1.9                        | 4,600                                | 0.9                            | 1    | 1.00 | \$1,610        | 2.96                          | 0.95         | 0.80 | 5           | 1.0             | \$8,050        |                               |
| COL00                              | Colado               |                        | C                          | 6.2                     | 0 /0                            | 1.9                        | 4,600                                | 1.6                            | 1    | 1.00 | \$1,610        | 4.96                          | 0.95         | 0.80 | 8           | 1.0             | \$12,880       |                               |
| DES00                              | Desert Peak          |                        | A                          | 33                      | 10 /0                           | 4.2                        | 5,500                                | 5.8                            | 2    | 1.00 | \$3,946        | 18.9                          | 0.50         | 0.70 | 11          | 1.0             | \$21,703       |                               |
| DES00                              | Desert Peak          |                        | A                          | 45                      | 10 /0                           | 4.2                        | 5,500                                | 8.8                            | 3    | 1.00 | \$5,919        | 28.5                          | 0.50         | 0.70 | 16          | 1.0             | \$31,568       |                               |
| EMP00                              | Empire (San Emidio)  | Field-wide summary     | A                          | 4.3                     | 4.8 /0                          | 2.6                        | 3,450                                | 0.0                            | 0    | 0.00 | \$0            | -0.29                         | 0.95         | 0.80 | 0           | 0.0             | \$0            |                               |
| EMP00                              | Empire (San Emidio)  | Field-wide summary     | A                          | 6.6                     | 4.8 /0                          | 2.6                        | 3,450                                | 0.5                            | 1    | 1.00 | \$1,192        | 1.68                          | 1.00         | 0.70 | 3           | 1.0             | \$3,576        |                               |
| FAL00                              | Fallon / Carson Lake | Carson Lake anomaly    | C                          | 34                      | 0 /0                            | 3.9                        | 6,567                                | 8.5                            | 4    | 1.00 | \$9,768        | 27.2                          | 0.95         | 0.80 | 18          | 1.0             | \$43,956       |                               |
| FAL00                              | Fallon / Carson Lake | Carson Lake anomaly    | C                          | 55                      | 0 /0                            | 3.9                        | 6,567                                | 13.8                           | 6    | 1.00 | \$14,652       | 44                            | 0.95         | 0.80 | 26          | 1.0             | \$63,492       |                               |

| PROJ<br>ID | Field or Area                   | Area or<br>Power Plant         | Explor.-<br>Devel.<br>Cat. | Estimated<br>Generation<br>Capacity(MW)    |              | (4)<br>Existing<br>Wellhd<br>MW | (5)<br>Est.<br>MW<br>/well | (6)<br>Expect<br>TD<br>/well<br>(ft) | (7)<br>Confirmation |                |                               |              | (8)<br>Development |             |                 |                |                               |  |
|------------|---------------------------------|--------------------------------|----------------------------|--|--------------|---------------------------------|----------------------------|--------------------------------------|---------------------|----------------|-------------------------------|--------------|--------------------|-------------|-----------------|----------------|-------------------------------|--|
|            |                                 |                                |                            | (3)<br>-----<br>Upper = Min<br>Lower = Mlk | Plan<br>(MW) |                                 |                            |                                      | Plan<br>(wells)     | Cost-<br>Fact. | Total<br>Drilling<br>(\$1000) | Plan<br>(MW) | I/P                | (P+I)<br>/T | Plan<br>(wells) | Cost-<br>Fact. | Total<br>Drilling<br>(\$1000) |  |
|            |                                 |                                |                            |  |              |                                 |                            |                                      |                     |                |                               |              |                    |             |                 |                |                               |  |
| FLY00      | Fly Ranch/Granite Ranch         | Ward's (Fly/Hualapi Flat) H.S. | C                          | 6  | 0/0          | 0.7                             | 8,350                      | 1.5                                  | 4                   | 1.00           | \$13,296                      | 4.8          | 0.95               | 0.80        | 18              | 1.0            | \$59,832                      |  |
| FLY00      | Fly Ranch/Granite Ranch         | Ward's (Fly/Hualapi Flat) H.S. | C                          | 8.7  | 0/0          | 0.7                             | 8,350                      | 2.2                                  | 5                   | 1.00           | \$16,620                      | 6.96         | 0.95               | 0.80        | 25              | 1.0            | \$83,100                      |  |
| FLY01      | Fly Ranch/Granite Ranch         | Granite Ranch                  | C                          | 5.4  | 0/0          | 3.4                             | 5,700                      | 1.4                                  | 1                   | 1.00           | \$2,057                       | 4.32         | 0.95               | 0.80        | 3               | 1.0            | \$6,171                       |  |
| FLY01      | Fly Ranch/Granite Ranch         | Granite Ranch                  | C                          | 8.1  | 0/0          | 3.4                             | 5,700                      | 2.0                                  | 1                   | 1.00           | \$2,057                       | 6.48         | 0.95               | 0.80        | 5               | 1.0            | \$10,285                      |  |
| GER00      | Gerlach                         | (Great Boiling Spring)         | C                          | 17   | 0/0          | 3.3                             | 7,700                      | 4.3                                  | 2                   | 1.00           | \$5,976                       | 13.6         | 0.95               | 0.80        | 10              | 1.0            | \$29,880                      |  |
| GER00      | Gerlach                         | (Great Boiling Spring)         | C                          | 25   | 0/0          | 3.3                             | 7,700                      | 6.3                                  | 3                   | 1.00           | \$8,964                       | 20           | 0.95               | 0.80        | 15              | 1.0            | \$44,820                      |  |
| HAZ00      | Hazen (Black Butte)             | (Patua Hot Springs)            | C                          | 6.3  | 0/0          | 3.1                             | 7,700                      | 1.6                                  | 1                   | 0.80           | \$2,390                       | 5.04         | 0.95               | 0.80        | 5               | 0.8            | \$11,952                      |  |
| HAZ00      | Hazen (Black Butte)             | (Patua Hot Springs)            | C                          | 8.5  | 0/0          | 3.1                             | 7,700                      | 2.1                                  | 1                   | 0.80           | \$2,390                       | 6.8          | 0.95               | 0.80        | 5               | 0.8            | \$11,952                      |  |
| HON00      | Honey Lake                      | Area-wide Summary              | A                          | 5.7  | 1.2/0        | 1.3                             | 3,750                      | 1.1                                  | 1                   | 1.00           | \$1,296                       | 3.66         | 0.95               | 0.80        | 8               | 1.0            | \$10,368                      |  |
| HON00      | Honey Lake                      | Area-wide Summary              | A                          | 8.3  | 1.2/0        | 1.3                             | 3,750                      | 1.8                                  | 2                   | 1.00           | \$2,592                       | 5.74         | 0.95               | 0.80        | 10              | 1.0            | \$12,960                      |  |
| KYL00      | Kyle Hot Springs (Granite Mtn.) | (Buena Vista Valley)           | C                          | 16   | 0/0          | 4.0                             | 7,700                      | 4.0                                  | 2                   | 1.00           | \$5,976                       | 12.8         | 0.95               | 0.80        | 8               | 1.0            | \$23,904                      |  |
| KYL00      | Kyle Hot Springs (Granite Mtn.) | (Buena Vista Valley)           | C                          | 22   | 0/0          | 4.0                             | 7,700                      | 5.5                                  | 2                   | 1.00           | \$5,976                       | 17.6         | 0.95               | 0.80        | 10              | 1.0            | \$29,880                      |  |
| LEA00      | Leach Hot Springs               | Grass Valley                   | C                          | 13   | 0/0          | 1.8                             | 8,500                      | 3.3                                  | 3                   | 1.00           | \$10,212                      | 10.4         | 0.95               | 0.80        | 15              | 1.0            | \$51,060                      |  |
| LEA00      | Leach Hot Springs               | Grass Valley                   | C                          | 18   | 0/0          | 1.8                             | 8,500                      | 4.5                                  | 4                   | 1.00           | \$13,616                      | 14.4         | 0.95               | 0.80        | 20              | 1.0            | \$68,080                      |  |
| LEE00      | Lee Hot Springs                 |                                | C                          | 5.4  | 0/0          | 2.8                             | 5,700                      | 1.4                                  | 1                   | 1.00           | \$2,057                       | 4.32         | 0.95               | 0.80        | 5               | 1.0            | \$10,285                      |  |
| LEE00      | Lee Hot Springs                 |                                | C                          | 9.4  | 0/0          | 2.8                             | 5,700                      | 2.4                                  | 1                   | 1.00           | \$2,057                       | 7.52         | 0.95               | 0.80        | 8               | 1.0            | \$16,456                      |  |
| NEW00      | New York Canyon                 |                                | C                          | 20   | 0/0          | 3.4                             | 5,700                      | 5.0                                  | 2                   | 1.00           | \$4,114                       | 16           | 0.95               | 0.80        | 13              | 1.0            | \$26,741                      |  |
| NEW00      | New York Canyon                 |                                | C                          | 26   | 0/0          | 3.4                             | 5,700                      | 6.5                                  | 3                   | 1.00           | \$6,171                       | 20.8         | 0.95               | 0.80        | 15              | 1.0            | \$30,855                      |  |

| PROJ<br>ID | Field or Area                        | Area or<br>Power Plant            | (2) Explor.-<br>Devel.<br>Cat. | Estimated<br>Generation<br>Capacity(MW) | (4) Existing<br>Wellhd<br>MW | (5) Est.<br>MW<br>/well | (6) Expect<br>TD<br>/well<br>(ft) | (7) Confirmation |                 |                |                               | (8) Development |      |             |                 |                |                               |
|------------|--------------------------------------|-----------------------------------|--------------------------------|---|------------------------------|-------------------------|-----------------------------------|------------------|-----------------|----------------|-------------------------------|-----------------|------|-------------|-----------------|----------------|-------------------------------|
|            |                                      |                                   |                                | (3) -----<br>Upper = Min<br>Lower = Mlk |                              |                         |                                   | Plan<br>(MW)     | Plan<br>(wells) | Cost-<br>Fact. | Total<br>Drilling<br>(\$1000) | Plan<br>(MW)    | I/P  | (P+I)<br>/T | Plan<br>(wells) | Cost-<br>Fact. | Total<br>Drilling<br>(\$1000) |
| NOR00      | North Valley                         |                                   | C                              | 37                                      | 0/0                          | 3.4                     | 4,950                             | 9.3              | 5               | 1.00           | \$8,740                       | 29.6            | 0.95 | 0.80        | 23              | 1.0            | \$40,204                      |
| NOR00      | North Valley                         |                                   | C                              | 49                                      | 0/0                          | 3.4                     | 4,950                             | 12.3             | 6               | 1.00           | \$10,488                      | 39.2            | 0.95 | 0.80        | 29              | 1.0            | \$50,692                      |
| PUM00      | Pumpnickel Valley                    | Tipton Ranch/Hot<br>Springs Ranch | C                              | 10                                      | 0/0.9                        | 2.4                     | 6,000                             | 1.6              | 1               | 1.00           | \$2,187                       | 8               | 0.95 | 0.80        | 8               | 1.0            | \$17,496                      |
| PUM00      | Pumpnickel Valley                    | Tipton Ranch/Hot<br>Springs Ranch | C                              | 13                                      | 0/0.9                        | 2.4                     | 6,000                             | 2.4              | 2               | 1.00           | \$4,374                       | 10.4            | 0.95 | 0.80        | 10              | 1.0            | \$21,870                      |
| PYR00      | Pyramid Lake Indian<br>Reserv.       | (Needle Rocks Hot<br>Springs)     | C                              | 9.9                                     | 0/0                          | 3.4                     | 7,000                             | 2.5              | 1               | 1.00           | \$2,645                       | 7.92            | 0.95 | 0.80        | 5               | 1.0            | \$13,225                      |
| PYR00      | Pyramid Lake Indian<br>Reserv.       | (Needle Rocks Hot<br>Springs)     | C                              | 14                                      | 0/0                          | 3.4                     | 7,000                             | 3.5              | 2               | 1.00           | \$5,290                       | 11.2            | 0.95 | 0.80        | 8               | 1.0            | \$21,160                      |
| RYE01      | Rye Patch-Humboldt<br>House District | Rye Patch                         | B                              | 16                                      | 0/10                         | 3.4                     | 5,280                             | 0.0              | 0               | 0.00           | \$0                           | 6.8             | 0.95 | 0.70        | 6               | 1.0            | \$11,286                      |
| RYE01      | Rye Patch-Humboldt<br>House District | Rye Patch                         | B                              | 20                                      | 0/10                         | 3.4                     | 5,280                             | 0.0              | 0               | 0.00           | \$0                           | 11              | 0.95 | 0.70        | 9               | 1.0            | \$16,929                      |
| RYE02      | Rye Patch-Humboldt<br>House District | Humboldt House                    | C                              | 27                                      | 0/0                          | 3.4                     | 5,700                             | 6.8              | 3               | 1.00           | \$6,171                       | 21.6            | 0.95 | 0.80        | 15              | 1.0            | \$30,855                      |
| RYE02      | Rye Patch-Humboldt<br>House District | Humboldt House                    | C                              | 34                                      | 0/0                          | 3.4                     | 5,700                             | 8.5              | 4               | 1.00           | \$8,228                       | 27.2            | 0.95 | 0.80        | 20              | 1.0            | \$41,140                      |
| SAW00      | Salt Wells                           | Eight Mile Flat                   | C                              | 63                                      | 0/0                          | 4.5                     | 5,700                             | 15.8             | 6               | 1.00           | \$12,342                      | 50.4            | 0.75 | 0.80        | 24              | 1.0            | \$49,368                      |
| SAW00      | Salt Wells                           | Eight Mile Flat                   | C                              | 96                                      | 0/0                          | 4.5                     | 5,700                             | 24.0             | 9               | 1.00           | \$18,513                      | 76.8            | 0.75 | 0.80        | 38              | 1.0            | \$78,166                      |
| SOD00      | Soda Lake                            | Soda Lake<br>No.1/No.2            | A                              | 29                                      | 16/0                         | 3.7                     | 4,850                             | 3.3              | 1               | 1.00           | \$1,708                       | 11.43           | 1.00 | 0.70        | 9               | 1.2            | \$18,446                      |
| SOD00      | Soda Lake                            | Soda Lake<br>No.1/No.2            | A                              | 42                                      | 16/0                         | 3.7                     | 4,850                             | 6.6              | 3               | 1.20           | \$6,149                       | 21.83           | 1.00 | 0.70        | 17              | 1.2            | \$34,843                      |
| STE00      | Steamboat Hot Sprs                   | Field-wide Summary                | A                              | 56                                      | 53/0                         | 3.9                     | 5,150                             | 0.8              | 1               | 0.00           | \$0                           | 5.05            | 0.50 | 0.90        | 2               | 0.4            | \$1,462                       |
| STE00      | Steamboat Hot Sprs                   | Field-wide Summary                | A                              | 62                                      | 53/0                         | 3.9                     | 5,150                             | 2.3              | 1               | 0.40           | \$731                         | 9.85            | 0.50 | 0.90        | 6               | 0.4            | \$4,387                       |

| PROJ<br>ID                                   | Field or Area                 | Area or<br>Power Plant                | (2)<br>Explor.-<br>Devel.<br>Cat. | Estimated<br>Generation<br>Capacity(MW) | (4)<br>Existing<br>Wellhd<br>MW | (5)<br>Est.<br>MW<br>/well | (6)<br>Expect<br>TD<br>/well<br>(ft) | (7)<br>Confirmation |                 |                | Total<br>Drilling<br>(\$1000) | (8)<br>Development |      |             |                 |                | Total<br>Drilling<br>(\$1000) |
|--|-------------------------------|---------------------------------------|-----------------------------------|---|---------------------------------|----------------------------|--------------------------------------|---------------------|-----------------|----------------|-------------------------------|--------------------|------|-------------|-----------------|----------------|-------------------------------|
|  |                               |                                       |                                   | (3)<br>Upper = Min<br>Lower = Mlk       |                                 |                            |                                      | Plan<br>(MW)        | Plan<br>(wells) | Cost-<br>Fact. |                               | Plan<br>(MW)       | I/P  | (P+I)<br>/T | Plan<br>(wells) | Cost-<br>Fact. |                               |
| STI00  | Stillwater                    | Stillwater<br>Geothermal 1            | A                                 | 11                                      | 14 /0                           | 2.7                        | 2,300                                | 0.0                 | 0               | 0.00           | \$0                           | -2.75              | 0.95 | 0.80        | 0               | 0.0            | \$0                           |
| STI00  | Stillwater                    | Stillwater<br>Geothermal 1            | A                                 | 18                                      | 14 /0                           | 2.7                        | 2,300                                | 0.9                 | 1               | 0.00           | \$0                           | 3.675              | 0.75 | 0.86        | 2               | 0.0            | \$0                           |
| STI01  | Stillwater                    | Stillwater N<br>Expansion             | B                                 | 16                                      | 0 /5                            | 3.1                        | 4,000                                | 0.0                 | 0               | 0.00           | \$0                           | 11.8               | 0.75 | 0.86        | 8               | 0.6            | \$6,653                       |
| STI01  | Stillwater                    | Stillwater N<br>Expansion             | B                                 | 24                                      | 0 /5                            | 3.1                        | 4,000                                | 1.0                 | 1               | 0.60           | \$832                         | 19.2               | 0.75 | 0.86        | 13              | 0.6            | \$10,811                      |
| TRI00  | Trinity Mountains<br>District | Telephone Well area D                 |                                   | 42                                      | 0 /0                            | 3.4                        | 5,600                                | 10.5                | 5               | 1.00           | \$10,075                      | 33.6               | 0.95 | 0.80        | 25              | 1.0            | \$50,375                      |
| TRI00  | Trinity Mountains<br>District | Telephone Well area D                 |                                   | 66                                      | 0 /0                            | 3.4                        | 5,600                                | 16.5                | 8               | 1.00           | \$16,120                      | 52.8               | 0.95 | 0.80        | 39              | 1.0            | \$78,585                      |
| WAB00  | Wabuska                       |                                       | A                                 | 8.1                                     | 1.4 /0                          | 1.4                        | 4,500                                | 1.7                 | 2               | 1.00           | \$3,144                       | 5.43               | 0.95 | 0.50        | 16              | 1.0            | \$25,152                      |
| WAB00  | Wabuska                       |                                       | A                                 | 13                                      | 1.4 /0                          | 1.4                        | 4,500                                | 2.9                 | 3               | 1.00           | \$4,716                       | 9.35               | 0.95 | 0.50        | 28              | 1.0            | \$44,016                      |
| <b>Area: 2 - NV with direct access to CA</b> |                               |                                       |                                   |   |                                 |                            |                                      |                     |                 |                |                               |                    |      |             |                 |                |                               |
| AUR00  | Aurora                        |                                       | C                                 | 31                                      | 0 /0                            | 3.4                        | 6,000                                | 7.8                 | 4               | 1.00           | \$8,748                       | 24.8               | 0.95 | 0.80        | 18              | 1.0            | \$39,366                      |
| AUR00  | Aurora                        |                                       | C                                 | 51                                      | 0 /0                            | 3.4                        | 6,000                                | 12.8                | 6               | 1.00           | \$13,122                      | 40.8               | 0.95 | 0.80        | 29              | 1.0            | \$63,423                      |
| DIX00  | Dixie Valley                  | Caithness Dixie<br>Valley             | A                                 | 71                                      | 66 /0                           | 5.3                        | 9,500                                | 1.3                 | 1               | 1.00           | \$3,957                       | 7.3                | 1.40 | 0.75        | 3               | 0.6            | \$7,123                       |
| DIX00  | Dixie Valley                  | Caithness Dixie<br>Valley             | A                                 | 107                                     | 66 /0                           | 5.3                        | 9,500                                | 10.3                | 3               | 0.50           | \$5,936                       | 36.1               | 1.40 | 0.75        | 23              | 0.6            | \$54,607                      |
| DIX01  | Dixie Valley                  | Dixie Valley Power<br>Partners (DVPP) | C                                 | 107                                     | 0 /0                            | 5.7                        | 10,000                               | 26.8                | 8               | 1.00           | \$33,984                      | 85.6               | 0.75 | 0.80        | 33              | 1.0            | \$140,184                     |
| DIX01  | Dixie Valley                  | Dixie Valley Power<br>Partners (DVPP) | C                                 | 151                                     | 0 /0                            | 5.7                        | 10,000                               | 37.8                | 11              | 1.00           | \$46,728                      | 120.8              | 0.75 | 0.80        | 46              | 1.0            | \$195,408                     |
| EMI00  | Emigrant (Fish Lake<br>V.)    |                                       | C                                 | 49                                      | 0 /0                            | 3.3                        | 7,700                                | 12.3                | 6               | 1.00           | \$17,928                      | 39.2               | 0.95 | 0.80        | 29              | 1.0            | \$86,652                      |

| PROJ<br>ID         | Field or Area                 | Area or<br>Power Plant        | Estimated<br>Generation           |  | (4)<br>Existing<br>Wellhd<br>MW | (5)<br>Est.<br>MW<br>/well | (6)<br>Expect<br>TD<br>/well<br>(ft) | (7)<br>Confirmation |                 |                |                               | (8)<br>Development |      |             |                 |                |                               |
|--------------------|-------------------------------|-------------------------------|-----------------------------------|--|---------------------------------|----------------------------|--------------------------------------|---------------------|-----------------|----------------|-------------------------------|--------------------|------|-------------|-----------------|----------------|-------------------------------|
|                    |                               |                               | (2)<br>Explor.-<br>Devel.<br>Cat. | Capacity(MW)<br>-----<br>(3)<br>Upper = Min<br>Lower = Mlk |                                 |                            |                                      | Plan<br>(MW)        | Plan<br>(wells) | Cost-<br>Fact. | Total<br>Drilling<br>(\$1000) | Plan<br>(MW)       | I/P  | (P+I)<br>/T | Plan<br>(wells) | Cost-<br>Fact. | Total<br>Drilling<br>(\$1000) |
|                    |                               |                               |                                   |  |                                 |                            |                                      |                     |                 |                |                               |                    |      |             |                 |                |                               |
| EMI00              | Emigrant (Fish Lake V.)       |                               | C                                 | 85   | 0/0                             | 3.3                        | 7,700                                | 21.3                | 11              | 1.00           | \$32,868                      | 68                 | 0.95 | 0.80        | 51              | 1.0            | \$152,388                     |
| FIS00              | Fish Lake (Valley)            |                               | B                                 | 30   | 0/7.4                           | 3.7                        | 9,500                                | 0.1                 | 1               | 1.00           | \$3,957                       | 24                 | 0.95 | 0.80        | 15              | 1.0            | \$59,355                      |
| FIS00              | Fish Lake (Valley)            |                               | B                                 | 47   | 0/7.4                           | 3.7                        | 9,500                                | 4.4                 | 2               | 1.00           | \$7,914                       | 37.6               | 0.95 | 0.80        | 25              | 1.0            | \$98,925                      |
| HAW00              | Hawthorne                     |                               | C                                 | 8.7  | 0/0                             | 2.2                        | 6,500                                | 2.2                 | 2               | 1.00           | \$4,822                       | 6.96               | 0.95 | 0.80        | 8               | 1.0            | \$19,288                      |
| HAW00              | Hawthorne                     |                               | C                                 | 14   | 0/0                             | 2.2                        | 6,500                                | 3.5                 | 3               | 1.00           | \$7,233                       | 11.2               | 0.95 | 0.80        | 13              | 1.0            | \$31,343                      |
| HYD00              | Hyder Hot Springs             |                               | D                                 | 5.5  | 0/0                             | 1.4                        | 7,700                                | 1.4                 | 2               | 1.00           | \$5,976                       | 4.4                | 0.95 | 0.80        | 8               | 1.0            | \$23,904                      |
| HYD00              | Hyder Hot Springs             |                               | D                                 | 9.6  | 0/0                             | 1.4                        | 7,700                                | 2.4                 | 3               | 1.00           | \$8,964                       | 7.68               | 0.95 | 0.80        | 13              | 1.0            | \$38,844                      |
| PIR00              | Pirouette Mountain            | (S.Dixie Valley)              | D                                 | 16   | 0/0                             | 3.4                        | 5,700                                | 4.0                 | 2               | 1.00           | \$4,114                       | 12.8               | 0.95 | 0.80        | 10              | 1.0            | \$20,570                      |
| PIR00              | Pirouette Mountain            | (S.Dixie Valley)              | D                                 | 23   | 0/0                             | 3.4                        | 5,700                                | 5.8                 | 3               | 1.00           | \$6,171                       | 18.4               | 0.95 | 0.80        | 13              | 1.0            | \$26,741                      |
| SIL00              | Silver Peak                   | (Alum prospect)               | C                                 | 41   | 0/0                             | 3.4                        | 5,700                                | 10.3                | 5               | 1.00           | \$10,285                      | 32.8               | 0.95 | 0.80        | 25              | 1.0            | \$51,425                      |
| SIL00              | Silver Peak                   | (Alum prospect)               | C                                 | 78   | 0/0                             | 3.4                        | 5,700                                | 19.5                | 10              | 1.00           | \$20,570                      | 62.4               | 0.95 | 0.80        | 44              | 1.0            | \$90,508                      |
| SOH00              | Sou Hot Springs               | (Seven Devils/Gilbert's H.S.) | D                                 | 3.3  | 0/0                             | 2.0                        | 5,700                                | 0.8                 | 1               | 1.00           | \$2,057                       | 2.64               | 0.95 | 0.80        | 3               | 1.0            | \$6,171                       |
| SOH00              | Sou Hot Springs               | (Seven Devils/Gilbert's H.S.) | D                                 | 6.1  | 0/0                             | 2.0                        | 5,700                                | 1.5                 | 1               | 1.00           | \$2,057                       | 4.88               | 0.95 | 0.80        | 5               | 1.0            | \$10,285                      |
| Area: 3 - Other NV |                               |                               |                                   |  |                                 |                            |                                      |                     |                 |                |                               |                    |      |             |                 |                |                               |
| BAL00              | Baltazor                      |                               | C                                 | 11   | 0/0                             | 2.6                        | 8,000                                | 2.8                 | 2               | 1.00           | \$6,282                       | 8.8                | 0.95 | 0.80        | 8               | 1.0            | \$25,128                      |
| BAL00              | Baltazor                      |                               | C                                 | 16   | 0/0                             | 2.6                        | 8,000                                | 4.0                 | 3               | 1.00           | \$9,423                       | 12.8               | 0.95 | 0.80        | 13              | 1.0            | \$40,833                      |
| DOU00              | Double - Black Rk Hot Springs |                               | D                                 | 20   | 0/0                             | 1.6                        | 5,700                                | 5.0                 | 5               | 1.00           | \$10,285                      | 16                 | 0.95 | 0.80        | 25              | 1.0            | \$51,425                      |
| DOU00              | Double - Black Rk Hot Springs |                               | D                                 | 33   | 0/0                             | 1.6                        | 5,700                                | 8.3                 | 9               | 1.00           | \$18,513                      | 26.4               | 0.95 | 0.80        | 41              | 1.0            | \$84,337                      |

| PROJ<br>ID             | Field or Area        | Area or<br>Power Plant         | (2)<br>Explor.-<br>Devel.<br>Cat. | Estimated<br>Generation             | (4)<br>Existing<br>Wellhd<br>MW | (5)<br>Est.<br>MW<br>/well | (6)<br>Expect<br>TD<br>/well<br>(ft) | (7)<br>Confirmation |                 |                |                               | (8)<br>Development |      |             |                 |                |                               |
|------------------------|----------------------|--------------------------------|-----------------------------------|-------------------------------------|---------------------------------|----------------------------|--------------------------------------|---------------------|-----------------|----------------|-------------------------------|--------------------|------|-------------|-----------------|----------------|-------------------------------|
|                        |                      |                                |                                   | (3)<br>Capacity(MW)                 |                                 |                            |                                      |                     |                 |                |                               |                    |      |             |                 |                |                               |
|                        |                      |                                |                                   | -----<br>Upper = Min<br>Lower = Mlk |                                 |                            |                                      | Plan<br>(MW)        | Plan<br>(wells) | Cost-<br>Fact. | Total<br>Drilling<br>(\$1000) | Plan<br>(MW)       | I/P  | (P+I)<br>/T | Plan<br>(wells) | Cost-<br>Fact. | Total<br>Drilling<br>(\$1000) |
| MCG00                  | McGee Mountain       | (Painted Hills)                | C                                 | 19                                  | 0 /0                            | 3.4                        | 5,700                                | 4.8                 | 2               | 1.00           | \$4,114                       | 15.2               | 0.95 | 0.80        | 10              | 1.0            | \$20,570                      |
| MCG00                  | McGee Mountain       | (Painted Hills)                | C                                 | 28                                  | 0 /0                            | 3.4                        | 5,700                                | 7.0                 | 3               | 1.00           | \$6,171                       | 22.4               | 0.95 | 0.80        | 18              | 1.0            | \$37,026                      |
| PIN00                  | Pinto Hot Springs    |                                | D                                 | 18                                  | 0 /0                            | 3.8                        | 5,700                                | 4.5                 | 2               | 1.00           | \$4,114                       | 14.4               | 0.95 | 0.80        | 10              | 1.0            | \$20,570                      |
| PIN00                  | Pinto Hot Springs    |                                | D                                 | 29                                  | 0 /0                            | 3.8                        | 5,700                                | 7.3                 | 3               | 1.00           | \$6,171                       | 23.2               | 0.95 | 0.80        | 15              | 1.0            | \$30,855                      |
| SHO00                  | Shoshone-Reese River |                                | D                                 | 13                                  | 0 /0                            | 3.4                        | 5,700                                | 3.3                 | 2               | 1.00           | \$4,114                       | 10.4               | 0.95 | 0.80        | 8               | 1.0            | \$16,456                      |
| SHO00                  | Shoshone-Reese River |                                | D                                 | 18                                  | 0 /0                            | 3.4                        | 5,700                                | 4.5                 | 2               | 1.00           | \$4,114                       | 14.4               | 0.95 | 0.80        | 10              | 1.0            | \$20,570                      |
| WIL00                  | Wilson Hot Springs   |                                | D                                 | 10                                  | 0 /0                            | 3.4                        | 4,950                                | 2.5                 | 1               | 1.00           | \$1,748                       | 8                  | 0.95 | 0.80        | 5               | 1.0            | \$8,740                       |
| WIL00                  | Wilson Hot Springs   |                                | D                                 | 17                                  | 0 /0                            | 3.4                        | 4,950                                | 4.3                 | 2               | 1.00           | \$3,496                       | 13.6               | 0.95 | 0.80        | 10              | 1.0            | \$17,480                      |
| Area: 4 - All other CA |                      |                                |                                   |                                     |                                 |                            |                                      |                     |                 |                |                               |                    |      |             |                 |                |                               |
| BRW01                  | Brawley              | Brawley (North Brawley)        | B                                 | 88                                  | 0 /20                           | 6.7                        | 6,650                                | 2.0                 | 1               | 0.00           | \$0                           | 70.4               | 1.00 | 0.80        | 28              | 1.0            | \$69,468                      |
| BRW01                  | Brawley              | Brawley (North Brawley)        | B                                 | 135                                 | 0 /20                           | 6.7                        | 6,650                                | 13.8                | 3               | 1.00           | \$7,443                       | 108                | 1.00 | 0.80        | 40              | 1.0            | \$99,240                      |
| BRW02                  | Brawley              | East Brawley                   | B                                 | 85                                  | 0 /0                            | 6.9                        | 13,650                               | 21.3                | 5               | 1.00           | \$33,300                      | 68                 | 0.85 | 0.80        | 24              | 1.0            | \$159,840                     |
| BRW02                  | Brawley              | East Brawley                   | B                                 | 129                                 | 0 /0                            | 6.9                        | 13,650                               | 32.3                | 8               | 1.00           | \$53,280                      | 103.2              | 0.85 | 0.80        | 35              | 1.0            | \$233,100                     |
| BRW03                  | Brawley              | South Brawley (Mesquite field) | B                                 | 45                                  | 0 /0                            | 6.5                        | 14,000                               | 11.3                | 3               | 1.00           | \$20,754                      | 36                 | 0.85 | 0.80        | 14              | 1.0            | \$96,852                      |
| BRW03                  | Brawley              | South Brawley (Mesquite field) | B                                 | 62                                  | 0 /0                            | 6.5                        | 14,000                               | 15.5                | 4               | 1.00           | \$27,672                      | 49.6               | 0.85 | 0.80        | 19              | 1.0            | \$131,442                     |
| CAL00                  | Calistoga            |                                | C                                 | 17                                  | 0 /0                            | 2.5                        | 5,350                                | 4.3                 | 3               | 1.00           | \$5,730                       | 13.6               | 0.95 | 0.80        | 15              | 1.0            | \$28,650                      |
| CAL00                  | Calistoga            |                                | C                                 | 25                                  | 0 /0                            | 2.5                        | 5,350                                | 6.3                 | 4               | 1.00           | \$7,640                       | 20                 | 0.95 | 0.80        | 20              | 1.0            | \$38,200                      |
| COS00                  | Coso                 | Field-wide Summary             | A                                 | 246                                 | 280 /0                          | 7.5                        | 9,000                                | 0.0                 | 0               | 0.00           | \$0                           | -21.7              | 0.75 | 0.80        | 0               | 0.0            | \$0                           |
| COS00                  | Coso                 | Field-wide Summary             | A                                 | 355                                 | 280 /0                          | 7.5                        | 9,000                                | 18.8                | 4               | 2.30           | \$33,810                      | 74                 | 0.40 | 0.95        | 15              | 2.4            | \$132,300                     |
| DUN00                  | Dunes                |                                | C                                 | 7.4                                 | 0 /0                            | 3.0                        | 7,000                                | 1.9                 | 1               | 1.00           | \$2,645                       | 5.92               | 0.95 | 0.80        | 5               | 1.0            | \$13,225                      |
| DUN00                  | Dunes                |                                | C                                 | 11                                  | 0 /0                            | 3.0                        | 7,000                                | 2.8                 | 2               | 1.00           | \$5,290                       | 8.8                | 0.95 | 0.80        | 8               | 1.0            | \$21,160                      |

| PROJ<br>ID | Field or Area               | Area or<br>Power Plant | Explor.-<br>Devel.<br>Cat. | Estimated<br>Generation<br>Capacity(MW)    | (4)<br>Existing<br>Wellhd<br>MW | (5)<br>Est.<br>MW<br>/well | (6)<br>Expect<br>TD<br>/well<br>(ft) | (7)<br>Confirmation |                |                               |              | (8)<br>Development |             |                 |                |                               |             |
|------------|-----------------------------|------------------------|----------------------------|--|---------------------------------|----------------------------|--------------------------------------|---------------------|----------------|-------------------------------|--------------|--------------------|-------------|-----------------|----------------|-------------------------------|-------------|
|            |                             |                        |                            | -----<br>(3)<br>Upper = Min<br>Lower = Mlk |                                 |                            | Plan<br>(MW)                         | Plan<br>(wells)     | Cost-<br>Fact. | Total<br>Drilling<br>(\$1000) | Plan<br>(MW) | I/P                | (P+I)<br>/T | Plan<br>(wells) | Cost-<br>Fact. | Total<br>Drilling<br>(\$1000) |             |
|            |                             |                        |                            |  |                                 |                            |                                      |                     |                |                               |              |                    |             |                 |                |                               |             |
| EAS00      | East Mesa                   | Field-wide summary     | A                          | 119  | 62 /0                           | 2.7                        | 7,500                                | 14.3                | 9              | 1.40                          | \$36,389     | 48.7               | 1.25        | 0.92            | 45             | 1.4                           | \$181,944   |
| EAS00      | East Mesa                   | Field-wide summary     | A                          | 148  | 62 /0                           | 2.7                        | 7,500                                | 21.5                | 13             | 1.40                          | \$52,562     | 71.9               | 1.25        | 0.92            | 66             | 1.4                           | \$266,851   |
| GEY00      | Geysers                     | Field-wide Summary     | A                          | 1200                                       | 850 /0                          | 5.9                        | 9,500                                | 87.5                | 25             | 2.30                          | \$227,528    | 322.5              | 0.10        | 0.80            | 76             | 2.3                           | \$691,684   |
| GEY00      | Geysers                     | Field-wide Summary     | A                          | 1400                                       | 850 /0                          | 5.9                        | 9,500                                | 137.5               | 39             | 2.30                          | \$354,943    | 482.5              | 0.10        | 0.80            | 113            | 2.3                           | \$1,028,424 |
| GLA00      | Glamis                      |                        | D                          | 4.3  | 0 /0                            | 3.0                        | 10,000                               | 1.1                 | 1              | 0.80                          | \$3,398      | 3.44               | 0.95        | 0.80            | 3              | 0.8                           | \$10,195    |
| GLA00      | Glamis                      |                        | D                          | 6.4  | 0 /0                            | 3.0                        | 10,000                               | 1.6                 | 1              | 0.80                          | \$3,398      | 5.12               | 0.95        | 0.80            | 5              | 0.8                           | \$16,992    |
| HEB00      | Heber                       | Field-wide Summary     | A                          | 109  | 100 /0                          | 3.3                        | 6,000                                | 2.3                 | 1              | 0.70                          | \$1,531      | 12.2               | 0.95        | 0.84            | 10             | 0.7                           | \$15,309    |
| HEB00      | Heber                       | Field-wide Summary     | A                          | 142  | 100 /0                          | 3.3                        | 6,000                                | 10.5                | 5              | 0.70                          | \$7,654      | 38.6               | 0.95        | 0.84            | 27             | 0.7                           | \$41,334    |
| LAK00      | Lake City / Surprise Valley | Lake City              | B                          | 23   | 0 /2.5                          | 3.2                        | 6,000                                | 3.3                 | 2              | 1.00                          | \$4,374      | 18.4               | 0.95        | 0.80            | 15             | 1.0                           | \$32,805    |
| LAK00      | Lake City / Surprise Valley | Lake City              | B                          | 37   | 0 /2.5                          | 3.2                        | 6,000                                | 6.8                 | 4              | 1.00                          | \$8,748      | 29.6               | 0.95        | 0.80            | 23             | 1.0                           | \$50,301    |
| LVM00      | Long Valley - M-P Leases    | M-P Lease Summary      | A                          | 70   | 40 /0                           | 3.7                        | 3,675                                | 7.5                 | 3              | 0.70                          | \$2,667      | 26                 | 0.63        | 0.86            | 13             | 0.7                           | \$11,557    |
| LVM00      | Long Valley - M-P Leases    | M-P Lease Summary      | A                          | 111  | 40 /0                           | 3.7                        | 3,675                                | 17.8                | 8              | 0.70                          | \$7,112      | 58.8               | 0.63        | 0.86            | 30             | 0.7                           | \$26,670    |
| MED01      | Medicine Lake               | Fourmile Hill          | B                          | 25   | 0 /0                            | 5.1                        | 7,500                                | 6.3                 | 2              | 1.00                          | \$5,776      | 20                 | 0.50        | 0.80            | 8              | 1.0                           | \$23,104    |
| MED01      | Medicine Lake               | Fourmile Hill          | B                          | 36   | 0 /0                            | 5.1                        | 7,500                                | 9.0                 | 3              | 1.00                          | \$8,664      | 28.8               | 0.50        | 0.80            | 11             | 1.0                           | \$31,768    |
| MED02      | Medicine Lake               | Telephone Flat         | B                          | 110  | 0 /15                           | 6.1                        | 6,750                                | 12.5                | 3              | 1.00                          | \$7,581      | 88                 | 0.50        | 0.80            | 26             | 1.0                           | \$65,702    |
| MED02      | Medicine Lake               | Telephone Flat         | B                          | 175  | 0 /15                           | 6.1                        | 6,750                                | 28.8                | 8              | 1.00                          | \$20,216     | 140                | 0.50        | 0.80            | 44             | 1.0                           | \$111,188   |
| MOS00      | Mount Signal                |                        | C                          | 12   | 0 /0                            | 3.4                        | 4,450                                | 3.0                 | 1              | 1.20                          | \$1,864      | 9.6                | 0.95        | 0.80            | 8              | 1.2                           | \$14,909    |
| MOS00      | Mount Signal                |                        | C                          | 19   | 0 /0                            | 3.4                        | 4,450                                | 4.8                 | 2              | 1.20                          | \$3,727      | 15.2               | 0.95        | 0.80            | 10             | 1.2                           | \$18,636    |
| NIL00      | Niland                      |                        | B                          | 59   | 0 /0                            | 7.3                        | 12,000                               | 14.8                | 3              | 0.80                          | \$13,217     | 47.2               | 0.85        | 0.80            | 14             | 0.8                           | \$61,678    |
| NIL00      | Niland                      |                        | B                          | 76   | 0 /0                            | 7.3                        | 12,000                               | 19.0                | 4              | 0.80                          | \$17,622     | 60.8               | 0.85        | 0.80            | 19             | 0.8                           | \$83,706    |
| RAN00      | Randsburg                   |                        | C                          | 32   | 0 /0                            | 3.4                        | 4,550                                | 8.0                 | 4              | 1.00                          | \$6,364      | 25.6               | 0.95        | 0.80            | 20             | 1.0                           | \$31,820    |

| PROJ<br>ID | Field or Area         | Area or<br>Power Plant | Estimated<br>Generation    |                                   | (4)<br>Existing<br>Wellhd<br>MW | (5)<br>Est.<br>MW<br>/well | (6)<br>Expect<br>TD<br>/well<br>(ft) | (7)<br>Confirmation |      |                |                               | (8)<br>Development |      |             |                 |                |                               |
|------------|-----------------------|------------------------|----------------------------|-----------------------------------|---------------------------------|----------------------------|--------------------------------------|---------------------|------|----------------|-------------------------------|--------------------|------|-------------|-----------------|----------------|-------------------------------|
|            |                       |                        | Explor.-<br>Devel.<br>Cat. | (3)<br>Upper = Min<br>Lower = Mlk |                                 |                            |                                      | Plan                | Plan | Cost-<br>Fact. | Total<br>Drilling<br>(\$1000) | Plan<br>(MW)       | I/P  | (P+I)<br>/T | Plan<br>(wells) | Cost-<br>Fact. | Total<br>Drilling<br>(\$1000) |
|            |                       |                        |                            |                                   |                                 |                            |                                      |                     |      |                |                               |                    |      |             |                 |                |                               |
|            |                       |                        |                            |                                   |                                 |                            |                                      |                     |      |                |                               |                    |      |             |                 |                |                               |
| RAN00      | Randsburg             | C                      | 48                         | 0 / 0                             | 3.4                             | 4,550                      | 12.0                                 | 6                   | 1.00 | \$9,546        | 38.4                          | 0.95               | 0.80 | 26          | 1.0             | \$41,366       |                               |
| SAL00      | Salton Sea            | Field-wide summary     | A                          | 1350                              | 350 / 0                         | 8.0                        | 10,250                               | 250.0               | 52   | 0.40           | \$91,458                      | 817.5              | 0.84 | 0.90        | 209             | 0.4            | \$367,589                     |
| SAL00      | Salton Sea            | Field-wide summary     | A                          | 1750                              | 350 / 0                         | 8.0                        | 10,250                               | 350.0               | 73   | 0.40           | \$128,392                     | 1138               | 0.84 | 0.90        | 290             | 0.4            | \$510,052                     |
| SES00      | Sespe Hot Springs     |                        | D                          | 3.6                               | 0 / 0                           | 1.8                        | 5,700                                | 0.9                 | 1    | 1.00           | \$2,057                       | 2.88               | 0.95 | 0.80        | 5               | 1.0            | \$10,285                      |
| SES00      | Sespe Hot Springs     |                        | D                          | 5.3                               | 0 / 0                           | 1.8                        | 5,700                                | 1.3                 | 1    | 1.00           | \$2,057                       | 4.24               | 0.95 | 0.80        | 5               | 1.0            | \$10,285                      |
| SUL00      | Sulphur Bank          | Clear Lake             | B                          | 27                                | 0 / 0                           | 5.0                        | 5,163                                | 6.8                 | 2    | 1.00           | \$3,666                       | 21.6               | 0.75 | 0.80        | 9               | 1.0            | \$16,497                      |
| SUL00      | Sulphur Bank          | Clear Lake             | B                          | 43                                | 0 / 0                           | 5.0                        | 5,163                                | 10.8                | 4    | 1.00           | \$7,332                       | 34.4               | 0.75 | 0.80        | 15              | 1.0            | \$27,495                      |
| SUP00      | Superstition Mountain |                        | D                          | 5.9                               | 0 / 0                           | 3.4                        | 5,700                                | 1.5                 | 1    | 1.00           | \$2,057                       | 4.72               | 0.95 | 0.80        | 3               | 1.0            | \$6,171                       |
| SUP00      | Superstition Mountain |                        | D                          | 9.5                               | 0 / 0                           | 3.4                        | 5,700                                | 2.4                 | 1    | 2.00           | \$4,114                       | 7.6                | 0.95 | 0.80        | 5               | 1.0            | \$10,285                      |

1. *Methods of cost estimation are described in Appendices IV, V and VI. Background information concerning the data in this table is listed at the database command buttons for Confirmation and Development Costs, summarized in the project-specific reports entitled "Exploration - Confirmation - Development Programs and Costs" (of which Appendix V is an example), as well as in Tables 8, 9 and 10.*

2. *Exploration-Development Category:*

*A = existing power plant operating*

*B = one or more wells tested at  $\geq 1$  MW*

*C = a temperature  $\geq 212^{\circ}\text{F}$  has been logged downhole (or boiling temperature for local elevation)*

*D = other exploration data (such as spring chemistry and/or shallow temperature gradient measurements)*

3. *Min = Minimum = estimated generation capacity with Monte Carlo simulation cumulative probability of more than 90% (MW for 30 years)*

*MLk = Most-likely = Monte Carlo simulation modal generation capacity (MW for 30 years)*

4. *The number to the left is actual gross generation (Exploration-Development Category A, most recent year available (assumed sustainable for 30 years)). The number to the right is MW proven at the wellhead but not in use at a power plant.*

5. *Estimated MW per production well. This is the initial, nominal estimate based on resource temperature; drilling cost factors not equal to 1 may compensate if there is information that suggests a different value. See the comments to confirmation and development costs for each project in Tables 9 and 10.*

6. *Expected total depth of each well. This is the initial, nominal estimate based on average depth of the resource; drilling cost factors not equal to 1 may compensate if there is information that suggests a different value. See the comments to confirmation and development costs for each project in Tables 9 and 10.*

7. *Confirmation drilling plan:*

*Plan (MW) = wellhead MW to confirm*

*Plan (wells) = total number of wells to plan to drill if success rate is 60%. (The initial, nominal estimate; a drilling cost factor not equal to 1 may compensate if there is information that suggests a different value. See the comments to confirmation costs for each project in Table 9.)*

*Cost Factor = drilling cost factor*

*Total Drilling (\$1000) = estimated total drilling expense. For projects in the Imperial Valley, California, Total Drilling Cost does NOT include corrosion-resistant titanium casing, which is estimated as a separate part of total confirmation cost.*

8. *Development drilling plan:*

*Plan (MW) = wellhead MW to develop for 105% of capacity.*

*I/P = expected ratio of injectors to producers that will be needed.*

*(P+I)/T = expected overall drilling success rate = sum of producers plus injectors divided by total number of wells drilled.*

*Plan (wells) = total number of wells to plan to drill, given I/P and (P+I)/T. (The initial, nominal estimate; a drilling cost factor not equal to 1 may compensate if there is information that suggests a different value. See the comments to development costs for each project in Table 10.)*

*Cost Factor = drilling cost factor*

*Total Drilling (\$1000) = estimated total drilling expense. (For projects in the Imperial Valley, California, Total Drilling Cost does NOT include corrosion-resistant titanium casing, which is estimated as a separate part of total development cost.*



**Hetch Hetchy/SFPUC Programmatic Renewable Energy Project**  
**Project: 1.3 New Geothermal Site Identification and Qualification**  
**Project Team: GeothermEx, Inc.**  
**Task: 1.3.10 Final Project Report**  
**Subject: D.1.3.10.3 Final Report**

**Table 12. Exploration, Confirmation and Site Development Cost Estimates - per kW**

| PROJ<br>ID                         | Field or Area                   | Area or Power Plant            | Explor.-<br>Devel.<br>Cat. | Min Estimated<br>Development<br>(Gross MW) <sup>(1)</sup> |       |     | Cost/kW <sup>(2)</sup> |                   |                   | Mlk Estimated<br>Development<br>(Gross MW) <sup>(1)</sup> |       |      | Cost/kW <sup>(2)</sup> |                   |                   |         |          |
|------------------------------------|---------------------------------|--------------------------------|----------------------------|---|-------|-----|------------------------|-------------------|-------------------|---|-------|------|------------------------|-------------------|-------------------|---------|----------|
|                                    |                                 |                                |                            | Wells   | Plant | New | Explore                | Expl +<br>Confirm | E+C+<br>Site Dev. | Wells   | Plant | New  | Explore                | Expl +<br>Confirm | E+C+<br>Site Dev. |         |          |
| Area: 1 - Greater Reno (NV and CA) |                                 |                                |                            |   |       |     |                        |                   |                   |   |       |      |                        |                   |                   |         |          |
| BEO00                              | Beowawe                         |                                | A                          | 15  | 13.3  | 15  |                        | \$329             | \$329             | \$3,532   | 26    | 24.3 | 26                     |                   | \$372             | \$372   | \$3,627  |
| BLU00                              | Blue Mountain                   |                                | C                          | 16  | 16    | 16  | \$3                    | \$194             | \$197             | \$2,471   | 30    | 30   | 30                     | \$2               | \$204             | \$205   | \$2,448  |
| BRA00                              | Brady's Hot Springs             |                                | A                          | 0   | 0     | 0   |                        |                   |                   |   | 3     | 0    | 3                      |                   | \$976             | \$976   | \$3,387  |
| COL00                              | Colado                          |                                | C                          | 3.7   | 3.7   | 3.7 | \$250                  | \$564             | \$814             | \$4,489   | 6.2   | 6.2  | 6.2                    | \$149             | \$336             | \$485   | \$4,063  |
| DES00                              | Desert Peak                     |                                | A                          | 23  | 22    | 23  |                        | \$211             | \$211             | \$2,589   | 35    | 34   | 35                     |                   | \$207             | \$207   | \$2,566  |
| EMP00                              | Empire (San Emidio)             | Field-wide summary             | A                          | 0   | 0     | 0   |                        |                   |                   |   | 1.8   | 1.8  | 1.8                    |                   | \$885             | \$885   | \$4,372  |
| FAL00                              | Fallon / Carson Lake            | Carson Lake anomaly            | C                          | 34  | 34    | 34  | \$1                    | \$347             | \$349             | \$3,142   | 55    | 55   | 55                     | \$1               | \$322             | \$323   | \$2,978  |
| FLY00                              | Fly Ranch/Granite Ranch         | Ward's (Fly/Hualapi Flat) H.S. | C                          | 6   | 6     | 6   |                        | \$2,664           | \$2,664           | \$12,636  | 8.7   | 8.7  | 8.7                    |                   | \$2,297           | \$2,297 | \$11,849 |
| FLY01                              | Fly Ranch/Granite Ranch         | Granite Ranch                  | C                          | 5.4   | 5.4   | 5.4 | \$111                  | \$484             | \$596             | \$3,238   | 8.1   | 8.1  | 8.1                    | \$74              | \$323             | \$397   | \$3,167  |
| GER00                              | Gerlach                         | (Great Boiling Spring)         | C                          | 17  | 17    | 17  | \$2                    | \$426             | \$429             | \$3,686   | 25    | 25   | 25                     | \$1               | \$434             | \$436   | \$3,729  |
| HAZ00                              | Hazen (Black Butte)             | (Patua Hot Springs)            | C                          | 6.3   | 6.3   | 6.3 | \$159                  | \$478             | \$637             | \$4,034   | 8.5   | 8.5  | 8.5                    | \$118             | \$354             | \$472   | \$3,378  |
| HON00                              | Honey Lake                      | Area-wide Summary              | A                          | 4.5   | 0     | 4.5 |                        | \$381             | \$381             | \$2,685   | 7.1   | 1.9  | 7.1                    |                   | \$458             | \$458   | \$2,684  |
| KYL00                              | Kyle Hot Springs (Granite Mtn.) | (Buena Vista Valley)           | C                          | 16  | 16    | 16  | \$51                   | \$453             | \$505             | \$3,499   | 22    | 22   | 22                     | \$37              | \$330             | \$367   | \$3,225  |
| LEA00                              | Leach Hot Springs               | Grass Valley                   | C                          | 13  | 13    | 13  | \$31                   | \$949             | \$980             | \$6,407   | 18    | 18   | 18                     | \$22              | \$913             | \$935   | \$6,218  |
| LEE00                              | Lee Hot Springs                 |                                | C                          | 5.4   | 5.4   | 5.4 | \$175                  | \$484             | \$659             | \$4,064   | 9.4   | 9.4  | 9.4                    | \$101             | \$278             | \$379   | \$3,629  |
| NEW00                              | New York Canyon                 |                                | C                          | 20  | 20    | 20  | \$59                   | \$252             | \$312             | \$3,149   | 26    | 26   | 26                     | \$46              | \$291             | \$336   | \$3,023  |
| NOR00                              | North Valley                    |                                | C                          | 37  | 37    | 37  | \$8                    | \$288             | \$296             | \$2,882   | 49    | 49   | 49                     | \$6               | \$261             | \$267   | \$2,802  |
| PUM00                              | Pumpnickel Valley               | Tipton Ranch/Hot Springs Ranch | C                          | 9.1   | 10    | 10  | \$14                   | \$277             | \$291             | \$3,541   | 12.1  | 13   | 13                     | \$11              | \$412             | \$423   | \$3,605  |
| PYR00                              | Pyramid Lake Indian Reserv.     | (Needle Rocks Hot Springs)     | C                          | 9.9   | 9.9   | 9.9 | \$14                   | \$334             | \$349             | \$3,184   | 14    | 14   | 14                     | \$10              | \$460             | \$470   | \$3,481  |

| PROJ ID                               | Field or Area                     | Area or Power Plant                | Explor.-<br>Devel.<br>Cat. | Min Estimated Development (Gross MW) <sup>(1)</sup> |       |      | Cost/kW <sup>(2)</sup> |         |              |                | Mlk Estimated Development (Gross MW) <sup>(1)</sup> |       |       | Cost/kW <sup>(2)</sup> |         |              |                |         |
|---------------------------------------|-----------------------------------|------------------------------------|----------------------------|---|-------|------|------------------------|---------|--------------|----------------|---|-------|-------|------------------------|---------|--------------|----------------|---------|
|                                       |                                   |                                    |                            | Wells   | Plant | New  | Explore                | Confirm | Expl + Conf. | E+C+ Site Dev. | Wells   | Plant | New   | Explore                | Confirm | Expl + Conf. | E+C+ Site Dev. |         |
| RYE01                                 | Rye Patch-Humboldt House District | Rye Patch                          | B                          | 6   | 3.5   | 6    |                        | \$      |              | \$             | \$4,319   | 10    | 7.5   | 10                     |         | \$           | \$             | \$3,755 |
| RYE02                                 | Rye Patch-Humboldt House District | Humboldt House                     | C                          | 27  | 27    | 27   |                        | \$280   | \$280        |                | \$2,923   | 34    | 34    | 34                     |         | \$296        | \$296          | \$3,006 |
| SAW00                                 | Salt Wells                        | Eight Mile Flat                    | C                          | 63  | 63    | 63   | \$16                   | \$238   | \$254        |                | \$2,537   | 96    | 96    | 96                     | \$10    | \$233        | \$243          | \$2,558 |
| SOD00                                 | Soda Lake                         | Soda Lake No. 1/No.2               | A                          | 13.3  | 2.9   | 13.3 | \$5                    | \$166   | \$170        |                | \$1,884   | 26.3  | 15.9  | 26.3                   | \$2     | \$287        | \$290          | \$2,521 |
| STE00                                 | Steamboat Hot Sprs                | Field-wide Summary                 | A                          | 3   | 0     | 3    |                        | \$      |              | \$             | \$487   | 9     | 2.16  | 9                      |         | \$116        | \$116          | \$964   |
| STI00                                 | Stillwater                        | Stillwater Geothermal 1            | A                          | 0   | 0     | 0    |                        |         |              |                |   | 0     | 0     | 0                      |         |              |                |         |
| STI01                                 | Stillwater                        | Stillwater N Expansion             | B                          | 11  | 16    | 16   |                        | \$      |              | \$             | \$1,475   | 19    | 24    | 24                     |         | \$49         | \$49           | \$1,705 |
| TRI00                                 | Trinity Mountains District        | Telephone Well area                | D                          | 42  | 42    | 42   | \$23                   | \$292   | \$314        |                | \$3,014   | 66    | 66    | 66                     | \$14    | \$296        | \$310          | \$3,001 |
| WAB00                                 | Wabuska                           |                                    | A                          | 6.7   | 6.65  | 6.7  | \$18                   | \$582   | \$600        |                | \$5,843   | 11.6  | 11.55 | 11.6                   | \$11    | \$503        | \$514          | \$5,802 |
| Area Totals :                         |                                   |                                    |                            | 413   | 396   | 419  |                        |         |              |                |   | 637   | 612   | 643                    |         |              |                |         |
| Area Averages (weighted) :            |                                   |                                    |                            |   |       |      |                        | \$21    | \$339        | \$360          | \$3,214   |       |       |                        | \$14    | \$332        | \$345          | \$3,157 |
| Area: 2 - NV with direct access to CA |                                   |                                    |                            |   |       |      |                        |         |              |                |   |       |       |                        |         |              |                |         |
| AUR00                                 | Aurora                            |                                    | C                          | 31  | 31    | 31   | \$28                   | \$342   | \$370        |                | \$3,140   | 51    | 51    | 51                     | \$17    | \$312        | \$329          | \$3,073 |
| DIX00                                 | Dixie Valley                      | Caithness Dixie Valley             | A                          | 5   | 5     | 5    |                        | \$972   | \$972        |                | \$3,897   | 41    | 41    | 41                     |         | \$176        | \$176          | \$3,008 |
| DIX01                                 | Dixie Valley                      | Dixie Valley Power Partners (DVPP) | C                          | 107   | 107   | 107  | \$1                    | \$380   | \$381        |                | \$3,191   | 151   | 151   | 151                    | \$      | \$370        | \$371          | \$3,165 |
| EMI00                                 | Emigrant (Fish Lake V.)           |                                    | C                          | 49  | 49    | 49   | \$1                    | \$441   | \$442        |                | \$3,710   | 85    | 85    | 85                     | \$1     | \$464        | \$464          | \$3,757 |
| FIS00                                 | Fish Lake (Valley)                |                                    | B                          | 22.6  | 30    | 30   | \$2                    | \$162   | \$164        |                | \$3,643   | 39.6  | 47    | 47                     | \$2     | \$203        | \$205          | \$3,809 |
| HAW00                                 | Hawthorne                         |                                    | C                          | 8.7   | 8.7   | 8.7  | \$4                    | \$676   | \$681        |                | \$4,398   | 14    | 14    | 14                     | \$3     | \$629        | \$632          | \$4,371 |
| HYD00                                 | Hyder Hot Springs                 |                                    | D                          | 5.5   | 5.5   | 5.5  | \$153                  | \$1,318 | \$1,471      |                | \$7,318   | 9.6   | 9.6   | 9.6                    | \$88    | \$1,131      | \$1,219        | \$6,765 |
| PIR00                                 | Pirouette Mountain                | (S.Dixie Valley)                   | D                          | 16  | 16    | 16   | \$74                   | \$316   | \$389        |                | \$3,175   | 23    | 23    | 23                     | \$51    | \$329        | \$380          | \$3,043 |
| SIL00                                 | Silver Peak                       | (Alum prospect)                    | C                          | 41  | 41    | 41   | \$1                    | \$305   | \$306        |                | \$3,060   | 78    | 78    | 78                     | \$      | \$319        | \$319          | \$2,980 |
| SOH00                                 | Sou Hot Springs                   | (Seven Devils/Gilbert's H.S.)      | D                          | 3.3   | 3.3   | 3.3  | \$279                  | \$792   | \$1,072      |                | \$4,442   | 6.1   | 6.1   | 6.1                    | \$151   | \$429        | \$580          | \$3,766 |
| Area Totals :                         |                                   |                                    |                            | 289   | 297   | 297  |                        |         |              |                |   | 498   | 506   | 506                    |         |              |                |         |
| Area Averages (weighted) :            |                                   |                                    |                            |   |       |      |                        | \$14    | \$391        | \$405          | \$3,436   |       |       |                        | \$8     | \$361        | \$369          | \$3,377 |

| PROJ<br>ID                 | Field or Area                 | Area or Power Plant            | Explor.-<br>Devel.<br>Cat. | Min Estimated<br>Development<br>(Gross MW) <sup>(1)</sup> |       |     |                        |                   |                 | Mlk Estimated<br>Development<br>(Gross MW) <sup>(1)</sup> |         |      |                        |         |                   |                 |                   |       |         |
|----------------------------|-------------------------------|--------------------------------|----------------------------|---|-------|-----|------------------------|-------------------|-----------------|---|---------|------|------------------------|---------|-------------------|-----------------|-------------------|-------|---------|
|                            |                               |                                |                            | Wells   | Plant | New | Cost/kW <sup>(2)</sup> |                   |                 | Wells   | Plant   | New  | Cost/kW <sup>(2)</sup> |         |                   |                 |                   |       |         |
|                            |                               |                                |                            |   |       |     | Explore                | Expl +<br>Confirm | Expl +<br>Conf. | E+C+<br>Site Dev.   |         |      |                        | Explore | Expl +<br>Confirm | Expl +<br>Conf. | E+C+<br>Site Dev. |       |         |
| Area: 3 - Other NV         |                               |                                |                            |   |       |     |                        |                   |                 |   |         |      |                        |         |                   |                 |                   |       |         |
| BAL00                      | Baltazor                      |                                | C                          | 11  | 11    | 11  |                        | \$692             | \$692           | \$4,476   | 16      | 16   | 16                     |         | \$713             | \$713           | \$4,765           |       |         |
| DOU00                      | Double - Black Rk Hot Springs |                                | D                          | 20  | 20    | 20  | \$220                  | \$625             | \$844           | \$4,916   | 33      | 33   | 33                     | \$133   | \$678             | \$811           | \$4,867           |       |         |
| MCG00                      | McGee Mountain                | (Painted Hills)                | C                          | 19  | 19    | 19  | \$50                   | \$266             | \$315           | \$2,898   | 28      | 28   | 28                     | \$34    | \$270             | \$304           | \$3,126           |       |         |
| PIN00                      | Pinto Hot Springs             |                                | D                          | 18  | 18    | 18  | \$57                   | \$280             | \$337           | \$2,980   | 29      | 29   | 29                     | \$35    | \$261             | \$296           | \$2,860           |       |         |
| SHO00                      | Shoshone-Reese River          |                                | D                          | 13  | 13    | 13  | \$67                   | \$388             | \$455           | \$3,221   | 18      | 18   | 18                     | \$49    | \$280             | \$329           | \$2,972           |       |         |
| WIL00                      | Wilson Hot Springs            |                                | D                          | 10  | 10    | 10  | \$74                   | \$225             | \$299           | \$2,673   | 17      | 17   | 17                     | \$44    | \$254             | \$298           | \$2,826           |       |         |
| Area Totals :              |                               |                                |                            | 91  | 91    | 91  |                        |                   |                 |   | 141     | 141  | 141                    |         |                   |                 |                   |       |         |
| Area Averages (weighted) : |                               |                                |                            |   |       |     |                        | \$88              | \$412           | \$500   | \$3,570 |      |                        |         |                   | \$57            | \$413             | \$470 | \$3,609 |
| Area: 4 - All other CA     |                               |                                |                            |   |       |     |                        |                   |                 |   |         |      |                        |         |                   |                 |                   |       |         |
| BRW01                      | Brawley                       | Brawley (North Brawley)        | B                          | 68  | 88    | 88  |                        | \$                | \$              | \$2,602   | 115     | 135  | 135                    |         | \$107             | \$107           | \$2,638           |       |         |
| BRW02                      | Brawley                       | East Brawley                   | B                          | 85  | 85    | 85  | \$1                    | \$562             | \$563           | \$4,238   | 129     | 129  | 129                    | \$1     | \$596             | \$597           | \$4,195           |       |         |
| BRW03                      | Brawley                       | South Brawley (Mesquite field) | B                          | 45  | 45    | 45  | \$2                    | \$671             | \$673           | \$4,658   | 62      | 62   | 62                     | \$1     | \$662             | \$663           | \$4,606           |       |         |
| CAL00                      | Calistoga                     |                                | C                          | 17  | 17    | 17  |                        | \$414             | \$414           | \$3,599   | 25      | 25   | 25                     |         | \$375             | \$375           | \$3,403           |       |         |
| COS00                      | Coso                          | Field-wide Summary             | A                          | 0   | 0     | 0   |                        |                   |                 |   | 75      | 55   | 75                     |         | \$541             | \$541           | \$3,405           |       |         |
| DUN00                      | Dunes                         |                                | C                          | 7.4   | 7.4   | 7.4 | \$113                  | \$447             | \$560           | \$3,847   | 11      | 11   | 11                     | \$76    | \$585             | \$661           | \$4,085           |       |         |
| EAS00                      | East Mesa                     | Field-wide summary             | A                          | 57  | 45.8  | 57  |                        | \$766             | \$766           | \$5,163   | 86      | 74.8 | 86                     |         | \$734             | \$734           | \$5,141           |       |         |
| GEY00                      | Geysers                       | Field-wide Summary             | A                          | 350   | 200   | 350 |                        | \$770             | \$770           | \$3,604   | 550     | 400  | 550                    |         | \$765             | \$765           | \$3,725           |       |         |
| GLA00                      | Glamis                        |                                | D                          | 4.3   | 4.3   | 4.3 | \$211                  | \$977             | \$1,188         | \$5,059   | 6.4     | 6.4  | 6.4                    | \$142   | \$656             | \$798           | \$4,953           |       |         |
| HEB00                      | Heber                         | Field-wide Summary             | A                          | 9   | 9     | 9   |                        | \$219             | \$219           | \$3,420   | 42      | 42   | 42                     |         | \$222             | \$222           | \$2,706           |       |         |
| LAK00                      | Lake City / Surprise Valley   | Lake City                      | B                          | 20.5  | 23    | 23  |                        | \$233             | \$233           | \$3,159   | 34.5    | 37   | 37                     |         | \$287             | \$287           | \$3,146           |       |         |
| LVM00                      | Long Valley - M-P Leases      | M-P Lease Summary              | A                          | 30  | 30    | 30  | \$82                   | \$112             | \$195           | \$580   | 71      | 71   | 71                     | \$35    | \$124             | \$159           | \$2,034           |       |         |
| MED01                      | Medicine Lake                 | Fourmile Hill                  | B                          | 25  | 25    | 25  |                        | \$281             | \$281           | \$2,705   | 36      | 36   | 36                     |         | \$292             | \$292           | \$2,674           |       |         |
| MED02                      | Medicine Lake                 | Telephone Flat                 | B                          | 95  | 110   | 110 |                        | \$84              | \$84            | \$2,181   | 160     | 175  | 175                    |         | \$139             | \$139           | \$2,275           |       |         |
| MOS00                      | Mount Signal                  |                                | C                          | 12  | 12    | 12  | \$37                   | \$199             | \$236           | \$2,978   | 19      | 19   | 19                     | \$23    | \$242             | \$265           | \$2,746           |       |         |
| NIL00                      | Niland                        |                                | B                          | 59  | 59    | 59  |                        | \$360             | \$360           | \$3,160   | 76      | 76   | 76                     |         | \$385             | \$385           | \$3,249           |       |         |

| PROJ<br>ID                 | Field or Area         | Area or Power Plant | Explor.-<br>Devel.<br>Cat. | Min Estimated<br>Development<br>(Gross MW) <sup>(1)</sup> |       |      |                        |         |                 |                   | Mlk Estimated<br>Development<br>(Gross MW) <sup>(1)</sup> |       |      |                        |         |                 |                   |
|----------------------------|-----------------------|---------------------|----------------------------|---|-------|------|------------------------|---------|-----------------|-------------------|---|-------|------|------------------------|---------|-----------------|-------------------|
|                            |                       |                     |                            |   |       |      | Cost/kW <sup>(2)</sup> |         |                 |                   |   |       |      | Cost/kW <sup>(2)</sup> |         |                 |                   |
|                            |                       |                     |                            | Wells   | Plant | New  | Explore                | Confirm | Expl +<br>Conf. | E+C+<br>Site Dev. | Wells   | Plant | New  | Explore                | Confirm | Expl +<br>Conf. | E+C+<br>Site Dev. |
| RAN00                      | Randsburg             |                     | C                          | 32  | 32    | 32   | \$14                   | \$243   | \$257           | \$2,752           | 48  | 48    | 48   | \$9                    | \$244   | \$253           | \$2,615           |
| SAL00                      | Salton Sea            | Field-wide summary  | A                          | 1000  | 1000  | 1000 |                        | \$136   | \$136           | \$2,261           | 1400  | 1400  | 1400 |                        | \$130   | \$130           | \$2,250           |
| SES00                      | Sespe Hot Springs     |                     | D                          | 3.6   | 3.6   | 3.6  | \$263                  | \$726   | \$989           | \$5,346           | 5.3   | 5.3   | 5.3  | \$178                  | \$493   | \$672           | \$4,112           |
| SUL00                      | Sulphur Bank          | Clear Lake          | B                          | 27  | 27    | 27   |                        | \$167   | \$167           | \$2,278           | 43  | 43    | 43   |                        | \$208   | \$208           | \$2,347           |
| SUP00                      | Superstition Mountain |                     | D                          | 5.9   | 5.9   | 5.9  | \$144                  | \$443   | \$587           | \$3,133           | 9.5   | 9.5   | 9.5  | \$89                   | \$539   | \$629           | \$3,211           |
| Area Totals :              |                       |                     |                            | 1953  | 1829  | 1990 |                        |         |                 |                   | 3004  | 2860  | 3041 |                        |         |                 |                   |
| Area Averages (weighted) : |                       |                     |                            |   |       |      | \$4                    | \$306   | \$310           | \$2,796           |   |       |      | \$2                    | \$324   | \$326           | \$2,857           |
| Grand Totals :             |                       |                     |                            | 2746  | 2613  | 2797 |                        |         |                 |                   | 4280  | 4119  | 4331 |                        |         |                 |                   |
| Grand Averages (weighted): |                       |                     |                            |   |       |      | \$10                   | \$324   | \$334           | \$2,952           |   |       |      | \$6                    | \$332   | \$339           | \$2,987           |

**Notes:**

(1) Gross MW of new wellhead production capacity and of new plant capacity needed to bring total electricity generation to the Minimum (Min) or Most-likely (Modal or Mlk) estimated generation capacity of the resource. The well and plant figures differ if there is existing unused (but proven) wellhead production capacity, or existing under-utilized plant capacity. A value of 0 indicates that the existing wellfield production capacity or plant capacity is very close to or exceeds the corresponding generation capacity estimate, so that no confirmation or development is planned and costed. These cases are explained in the notes to individual projects found in Tables 9 and 10. "New" is the larger of wellhead MW or plant MW and represents the total increment of electricity production (gross MW) to be expected. Development costs are actually calculated on the basis of drilling and proving 105% of needed gross MW, so that a reserve capacity is available.

(2) Costs/kW are calculated with respect to new gross MW.

Site Development does not include estimated transmission line costs.

**Hetch Hetchy/SFPUC Programmatic Renewable Energy Project**  
**Project: 1.3 New Geothermal Site Identification and Qualification**  
**Project Team: GeothermEx, Inc.**  
**Task: 1.3.10 Final Project Report**  
**Subject: D.1.3.10.3 Final Report**

***Table 13. Transmission Line Cost Estimates***

| <i>PROJID</i>                                    | <i>Cost</i>  | <i>Cost<br/>Factor</i> | <i>Total<br/>Cost</i> | <i>Comment</i>  |
|--|--------------|------------------------|-----------------------|---|
| <b><i>Area: 1 - Greater Reno (NV and CA)</i></b> |              |                        |                       |   |
| BEO00  | \$0          | 0.0                    | \$0                   | It is assumed that existing transmission can handle expansion.  |
| BLU00  | \$14,510,000 | 1.0                    | \$14,510,000          | Estimate based on data in Woo03a, for the Blue Mtn MW fraction of a collection system that connects to the PDCI (Woo03a Stage 4 project; see Appendix VI).  |
| BRA00  | \$0          | 0.0                    | \$0                   | Existing transmission to handle upgrade   |
| COL00  | \$3,650,000  | 1.0                    | \$3,650,000           | Estimate based on data in Woo03a, for the Colado MW fraction of a collection system that connects to the PDCI (Woo03a Stage 4 project; see Appendix VI).  |
| DES00  | \$0          | 0.0                    | \$0                   | Existing transmission capacity is assumed capable of handling the expansion.  |
| EMP00  | \$0          | 0.0                    | \$0                   | It is assumed that the existing transmission line can handle the expansion.   |
| FAL00  | \$12,410,000 | 1.0                    | \$12,410,000          | Estimate based on data in Woo03a for the Fallon/Carson MW fraction of a collection system from Lee H.S. to a 345 kV connection at Tracy (Woo03a Stage 3 project; see Appendix VI).  |
| FLY00  | \$7,320,000  | 0.5                    | \$3,660,000           | Estimate based on data in Woo03a for a line from Fly Ranch to Gerlach, plus a MW proportion of combined transmission from there to PDCI (see Appendix VI). Cost Factor = 0.5 represents assuming that one half of the Fly Ranch transmission cost is assigned to this project, and one-half to FLY00. |
| FLY01  | \$7,320,000  | 0.5                    | \$3,660,000           | Estimate based on data in Woo03a for a line from Fly Ranch to Gerlach, plus a MW proportion of combined transmission from there to PDCI (see Appendix VI). Cost Factor = 0.5 represents assuming that one half of the Fly Ranch transmission cost is assigned to this project, and one-half to FLY00. |
| GER00  | \$7,280,000  | 1.0                    | \$7,280,000           | Estimate based on data in Woo03a for transmission from Gerlach to the PDCI, adjusted for carrying power also from Fly Ranch (see Appendix VI).  |
| HAZ00  | \$5,730,000  | 1.0                    | \$5,730,000           | Estimate based on data in Woo03a, for transmission from Hazen to existing grid at Eagle (see Appendix VI).  |

| <i>PROJID</i> | <i>Cost</i>  | <i>Cost<br/>Factor</i> | <i>Total<br/>Cost</i> | <i>Comment</i>   |
|---------------|--------------|------------------------|-----------------------|--|
| HON00         | \$0          | 0.0                    | \$0                   | It is assumed that existing transmission capacity can handle the expansion.  |
| KYL00         | \$10,630,000 | 1.0                    | \$10,630,000          | Estimate based on data in Woo03a, for the Kyle H.S. MW fraction of a collection system that connects to the PDCI (Woo03a Stage 4 project; see Appendix VI).  |
| LEA00         | \$9,160,000  | 1.0                    | \$9,160,000           | Estimate based on data in Woo03a, for the Leach H.S. MW fraction of a collection system that connects to the PDCI (Woo03a Stage 4 project; see Appendix VI).   |
| LEE00         | \$5,960,000  | 1.0                    | \$5,960,000           | Estimate based on data in Woo03a for a line from Lee H.S. to Salt Wells (project SAW00), plus the Lee H.S. MW fraction of a collection system from Salt Wells to 345 kV connection at Tracy (Woo03a Stage 3 project; see Appendix VI). |
| NEW00         | \$12,800,000 | 1.0                    | \$12,800,000          | Estimate based on data in Woo03a, for the New York Canyon MW fraction of a collection system that connects to the PDCI (Woo03a Stage 4 project; see Appendix VI).  |
| NOR00         | \$7,020,000  | 1.0                    | \$7,020,000           | Estimate based on data in Woo03a for the North Valley MW fraction of a collection system to a 345 kV connection at Tracy (Woo03a Stage 3 project; see Appendix VI).  |
| PUM00         | \$8,500,000  | 1.0                    | \$8,500,000           | Estimate based on data in Woo03a, for the Pumpernickel Valley MW fraction of a collection system that connects to the PDCI (Woo03a Stage 4 project; see Appendix VI).  |
| PYR00         | \$268,000    | 21.0                   | \$5,628,000           | Cost Factor = c.21 miles NE to connect to a new 345 kV line between Honey Lake and the PDCI tap SW of Gerlach, that is part of the new developments in Woo03a  |
| RYE01         | \$9,200,000  | 1.0                    | \$9,200,000           | Estimate based on data in Woo03a, for the RYE01 MW fraction of a collection system that connects to the PDCI (Woo03a Stage 4 project; see Appendix VI).  |
| RYE02         | \$16,940,000 | 1.0                    | \$16,940,000          | Estimate based on data in Woo03a, for the RYE02 MW fraction of a collection system that connects to the PDCI (Woo03a Stage 4 project; see Appendix VI).  |
| SAW00         | \$31,640,000 | 1.0                    | \$31,640,000          | Estimate based on data in Woo03a for the Salt Wells MW fraction of a collection system from Lee H.S. through Salt Wells and other projects to a 345 kV connection at Tracy (Woo03a Stage 3 project; see Appendix VI).                  |
| SOD00         | \$0          | 0.0                    | \$0                   | It is assumed that existing transmission capacity can handle the expansion.  |
| STE00         | \$0          | 0.0                    | \$0                   | It is assumed that existing transmission capacity can handle the expansion.  |
| STI00         | \$0          | 0.0                    | \$0                   |  |

| <i>PROJID</i>                                | <i>Cost</i>  | <i>Cost<br/>Factor</i> | <i>Total<br/>Cost</i> | <i>Comment</i>  |
|--|--------------|------------------------|-----------------------|---|
| STI01  | \$0          | 0.0                    | \$0                   | It is assumed that existing transmission capacity can handle the expansion  |
| TRI00  | \$11,460,000 | 1.0                    | \$11,460,000          | Estimate based on data in Woo03a, for the Trinity MW fraction of a collection system that connects to the PDCI (Woo03a Stage 4 project; see Appendix VI).   |
| WAB00  | \$0          | 0.0                    | \$0                   | It is assumed that existing transmission capacity can handle the expansion.   |
| <i>Area: 2 - NV with direct access to CA</i> |              |                        |                       |   |
| AUR00  | \$268,000    | 2.0                    | \$536,000             | Cost Factor = about 2 miles to an existing 55-69 kV transmission line.  |
| DIX00  | \$0          | 0.0                    | \$0                   | Existing transmission capacity is assumed capable of handling an expansion.   |
| DIX01  | \$268,000    | 1.0                    | \$268,000             | Cost Factor = 1 mile distance (approximate) to existing Dixie Valley 230 kV line.   |
| EMI00  | \$268,000    | 16.0                   | \$4,288,000           | Cost Factor = c.17 miles SW to an existing transmission line terminus at N. Dyer, or c.15 miles E to an existing transmission line N of Silver Peak (both lines 55 kV). Transmission line costs would be greatly lowered by combining this project with development of the near-by Fish Lake project (FIS00). |
| FIS00  | \$268,000    | 13.0                   | \$3,484,000           | Cost Factor = c.13 miles S to an existing 55 kV terminus at N. Dyer. Transmission costs could be greatly reduced by simultaneous development of the near-by Emigrant anomaly (EMI00)  |
| HAW00  | \$268,000    | 1.0                    | \$268,000             | Cost Factor = assumed distance of 1 mile to existing transmission capacity that passes through  |
| HYD00  | \$286,000    | 6.0                    | \$1,716,000           | Cost Factor = c.6 miles to tie-in at the Dixie Valley development (DIX00)   |
| PIR00  | \$0          | 0.0                    | \$0                   | Assumed to be negligible (site is along the Dixie Valley transmission line)   |
| SIL00  | \$268,500    | 2.5                    | \$671,250             | Cost Factor = 2.5 miles E to an existing 55 kV transmission line  |
| SOH00  | \$268,500    | 10.0                   | \$2,685,000           | Cost Factor = c.10 miles to connect to transmission at the existing Dixie Valley project  |
| <i>Area: 3 - Other NV</i>                    |              |                        |                       |   |
| BAL00  | \$268,000    | 26.0                   | \$6,968,000           | Cost Factor = c.26 miles to Quinn River termination of existing 120 kV line. Another possibility is connection at Fields, Oregon (similar distance). Simultaneous development of and cost-sharing with near-by McGee Mtn. (MCG00) would reduce the cost by about 1/2.   |
| DOU00  | \$268,000    | 16.0                   | \$4,288,000           | Cost Factor = c.15 miles from the middle of the anomaly to existing 60 kV transmission to the S   |
| MCG00  | \$268,000    | 28.0                   | \$7,504,000           | Cost Factor = c.12 miles from McGee Mtn to Baltazor HS (BAL00) plus c.26 miles from there to the Quinn River termination of an existing 120 kV line. Another possibility from Baltazor is connection at Fields, Oregon (similar distance). Simultaneous development of and cost-sharing with Baltazor would   |

| <i>PROJID</i> | <i>Cost</i> | <i>Cost<br/>Factor</i> | <i>Total<br/>Cost</i> | <i>Comment</i> |
|---------------|-------------|------------------------|-----------------------|----------------|
|---------------|-------------|------------------------|-----------------------|----------------|

reduce the overall McGee cost by about 1/2. Without development of Baltazor, a line from McGee might go a shorter distance directly E to Quinn River, but over high mountains at higher cost/mile.

|                               |              |      |              |  |
|-------------------------------|--------------|------|--------------|--|
| PIN00                         | \$268,500    | 25.0 | \$6,712,500  | Cost Factor = c.25 miles NE to the terminus of an existing 120 kV line at Quinn River.   |
| SHO00                         | \$268,500    | 15.0 | \$4,027,500  | Cost Factor = c.15 miles N to an existing 55-69 kV transmission terminus at Antelope Valley. A 230 kV line is about 25 miles to the S.   |
| WIL00                         | \$268,500    | 17.0 | \$4,564,500  | Cost Factor = c.17 miles N to existing 55 kV transmission capacity near Yerington  |
| <i>Area: 4 - All other CA</i> |              |      |              |  |
| BRW01                         | \$20,900,000 | 1.0  | \$20,900,000 | The MW fraction of total cost to connect to the PDCI from SAL00 (Woo03a), plus a 16 mile transmission from BRW01 to SAL00. See Appendix VI.                                    |
| BRW02                         | \$21,900,000 | 1.0  | \$21,900,000 | The MW fraction of total cost to connect to the PDCI from SAL00 (Woo03a), plus a 16 mile transmission from BRW01 to SAL00. See Appendix VI.                                    |
| BRW03                         | \$12,900,000 | 1.0  | \$12,900,000 | The MW fraction of total cost to connect to the PDCI from SAL00 (Woo03a), plus a 16 mile transmission from BRW01 to SAL00. See Appendix VI.                                    |
| CAL00                         | \$268,000    | 1.0  | \$268,000    | Assume that existing transmission is within one mile.  |
| COS00                         | \$0          | 0.0  | \$0          | Existing transmission capacity is assumed capable of handling expansion.   |
| DUN00                         | \$180,000    | 14.0 | \$2,520,000  | Cost Factor = c.14 miles W to connection at East Mesa (EAS00)  |
| EAS00                         | \$0          | 0.0  | \$0          | It is assumed that existing transmission can handle any project expansion.   |
| GEY00                         | \$0          | 0.0  | \$0          | It is assumed that existing transmission lines can handle capacity expansion   |
| GLA00                         | \$180,000    | 18.0 | \$3,240,000  | Cost Factor = c.18 miles to existing transmission at East Mesa (EAS00)   |
| HEB00                         | \$0          | 0.0  | \$0          | It is assumed that existing transmission capacity can handle the expansion.  |
| LAK00                         | \$268,000    | 25.0 | \$6,700,000  | Cost Factor = assumed 25 mile line to the vicinity of Alturas (very uncertain)   |
| LVM00                         | \$0          | 0.0  | \$0          | It is assumed that existing transmission lines can handle the expansion.   |
| MED01                         | \$268,000    | 22.0 | \$5,896,000  | Cost Factor = c. 22 miles ENE to existing BPA Malin-Warner transmission line. Cost would be shared by additional or eventual development of the Telephone Flat project (MED02) |

| <i>PROJID</i> | <i>Cost</i>   | <i>Cost<br/>Factor</i> | <i>Total<br/>Cost</i> | <i>Comment</i>  |
|---------------|---------------|------------------------|-----------------------|---|
| MED02         | \$268,000     | 22.0                   | \$5,896,000           | Cost Factor = c. 22 miles ENE to existing BPA Malin-Warner transmission line. Cost would be shared by additional or eventual development of the Fourmile Hill project (MED01) |
| MOS00         | \$180,000     | 5.0                    | \$900,000             | Cost Factor = c.5 miles N to an existing 500 kV(?) transmission line  |
| NIL00         | \$10,900,000  | 1.0                    | \$10,900,000          | The MW fraction of total cost to connect to the PDCI from SAL00 (Woo03a), plus a 16 mile transmission from BRW01 to SAL00. See Appendix VI.                                   |
| RAN00         | \$268,000     | 20.0                   | \$5,360,000           | Cost Factor = c.20 miles W to existing transmission corridor  |
| SAL00         | \$184,500,000 | 1.0                    | \$184,500,00          | The MW fraction of total cost to connect new Imperial Valley development to the PDCI (Woo03a). See Appendix VI.   |
| SES00         | \$268,500     | 15.0                   | \$4,027,500           | Cost Factor = assumed 15 mile distance to an existing transmission corridor (very uncertain)  |
| SUL00         | \$268,500     | 2.0                    | \$537,000             | Cost Factor = approximate distance to an existing transmission line   |
| SUP00         | \$268,500     | 6.0                    | \$1,611,000           | Cost Factor = c.6 miles NE to an existing transmission line.  |



**Hetch Hetchy/SFPUC Programmatic Renewable Energy Project**  
**Project: 1.3 New Geothermal Site Identification and Qualification**  
**Project Team: GeothermEx, Inc.**  
**Task: 1.3.10 Final Project Report**  
**Subject: D.1.3.10.3 Final Report**

**Table 14. Site Development, Transmission Line and Total Cost Estimates - Totals and per kW**

| PROJ<br>ID                                | Field or Area                   | Area or Power Plant            | Explor.-<br>Devel.<br>Cat. | Min Estimated<br>Development<br>(Gross MW) (1) |       |     | Cost (thousands) (2) |           |           |          | Mlk Estimated<br>Development<br>(Gross MW)(1) |       |     | Cost (thousands) (2) |           |           |          |
|---|---------------------------------|--------------------------------|----------------------------|--|-------|-----|----------------------|-----------|-----------|----------|---|-------|-----|----------------------|-----------|-----------|----------|
|   |                                 |                                |                            | Wells  | Plant | New | Site Dev.            | E+C+SD+TL |           |          | Wells   | Plant | New | Site Dev.            | E+C+SD+TL |           |          |
|   |                                 |                                |                            |  |       |     | Tran.Ln.             | Tot.      | \$/kW     |          |   |       |     | Tran.Ln.             | Tot.      | \$/kW     |          |
| <b>Area: 1 - Greater Reno (NV and CA)</b> |                                 |                                |                            |  |       |     |                      |           |           |          |   |       |     |                      |           |           |          |
| BEO00                                     | Beowawe                         |                                | A                          | 15   | 13.3  | 15  | \$48,048             | \$        | \$52,978  | \$3,532  | 26  | 24.3  | 26  | \$84,618             | \$        | \$94,293  | \$3,627  |
| BLU00                                     | Blue Mountain                   |                                | C                          | 16   | 16    | 16  | \$36,376             | \$14,510  | \$54,044  | \$3,378  | 30  | 30    | 30  | \$67,277             | \$14,510  | \$87,947  | \$2,932  |
| BRA00                                     | Brady's Hot Springs             |                                | A                          | 0  | 0     | 0   | \$                   | \$        | \$        |          | 3   | 0     | 3   | \$7,233              | \$        | \$10,160  | \$3,387  |
| COL00                                     | Colado                          |                                | C                          | 3.7  | 3.7   | 3.7 | \$13,600             | \$3,650   | \$20,260  | \$5,476  | 6.2   | 6.2   | 6.2 | \$22,180             | \$3,650   | \$28,840  | \$4,652  |
| DES00                                     | Desert Peak                     |                                | A                          | 23   | 22    | 23  | \$54,703             | \$        | \$59,551  | \$2,589  | 35  | 34    | 35  | \$82,568             | \$        | \$89,825  | \$2,566  |
| EMP00                                     | Empire (San Emidio)             | Field-wide summary             | A                          | 0  | 0     | 0   | \$                   | \$        | \$        |          | 1.8   | 1.8   | 1.8 | \$6,276              | \$        | \$7,869   | \$4,372  |
| FAL00                                     | Fallon / Carson Lake            | Carson Lake anomaly            | C                          | 34   | 34    | 34  | \$94,956             | \$12,410  | \$119,222 | \$3,507  | 55  | 55    | 55  | \$145,992            | \$12,410  | \$176,185 | \$3,203  |
| FLY00                                     | Fly Ranch/Granite Ranch         | Ward's (Fly/Hualapi Flat) H.S. | C                          | 6  | 6     | 6   | \$59,832             | \$3,660   | \$79,473  | \$13,246 | 8.7   | 8.7   | 8.7 | \$83,100             | \$3,660   | \$106,746 | \$12,270 |
| FLY01                                     | Fly Ranch/Granite Ranch         | Granite Ranch                  | C                          | 5.4  | 5.4   | 5.4 | \$14,271             | \$3,660   | \$21,147  | \$3,916  | 8.1   | 8.1   | 8.1 | \$22,435             | \$3,660   | \$29,311  | \$3,619  |
| GER00                                     | Gerlach                         | (Great Boiling Spring)         | C                          | 17   | 17    | 17  | \$55,380             | \$7,280   | \$69,946  | \$4,114  | 25  | 25    | 25  | \$82,320             | \$7,280   | \$100,494 | \$4,020  |
| HAZ00                                     | Hazen (Black Butte)             | (Patua Hot Springs)            | C                          | 6.3  | 6.3   | 6.3 | \$21,402             | \$5,730   | \$31,145  | \$4,944  | 8.5   | 8.5   | 8.5 | \$24,702             | \$5,730   | \$34,445  | \$4,052  |
| HON00                                     | Honey Lake                      | Area-wide Summary              | A                          | 4.5  | 0     | 4.5 | \$10,368             | \$        | \$12,084  | \$2,685  | 7.1   | 1.9   | 7.1 | \$15,810             | \$        | \$19,059  | \$2,684  |
| KYL00                                     | Kyle Hot Springs (Granite Mtn.) | (Buena Vista Valley)           | C                          | 16   | 16    | 16  | \$47,904             | \$10,630  | \$66,606  | \$4,163  | 22  | 22    | 22  | \$62,880             | \$10,630  | \$81,582  | \$3,708  |
| LEA00                                     | Leach Hot Springs               | Grass Valley                   | C                          | 13   | 13    | 13  | \$70,560             | \$9,160   | \$92,456  | \$7,112  | 18  | 18    | 18  | \$95,080             | \$9,160   | \$121,077 | \$6,727  |
| LEE00                                     | Lee Hot Springs                 |                                | C                          | 5.4  | 5.4   | 5.4 | \$18,385             | \$5,960   | \$27,905  | \$5,168  | 9.4   | 9.4   | 9.4 | \$30,556             | \$5,960   | \$40,076  | \$4,263  |
| NEW00                                     | New York Canyon                 |                                | C                          | 20   | 20    | 20  | \$56,741             | \$12,800  | \$75,774  | \$3,789  | 26  | 26    | 26  | \$69,855             | \$12,800  | \$91,396  | \$3,515  |
| NOR00                                     | North Valley                    |                                | C                          | 37   | 37    | 37  | \$95,704             | \$7,020   | \$113,671 | \$3,072  | 49  | 49    | 49  | \$124,192            | \$7,020   | \$144,301 | \$2,945  |
| PUM00                                     | Pumpernickel Valley             | Tipton Ranch/Hot Springs Ranch | C                          | 9.1  | 10    | 10  | \$32,496             | \$8,500   | \$43,905  | \$4,391  | 12.1  | 13    | 13  | \$41,370             | \$8,500   | \$55,367  | \$4,259  |
| PYR00                                     | Pyramid Lake Indian Reserv.     | (Needle Rocks Hot Springs)     | C                          | 9.9  | 9.9   | 9.9 | \$28,075             | \$5,628   | \$37,154  | \$3,753  | 14  | 14    | 14  | \$42,160             | \$5,628   | \$54,366  | \$3,883  |

| PROJ<br>ID                              | Field or Area                     | Area or Power Plant                | Explor.-<br>Devel.<br>Cat. | Min Estimated<br>Development<br>(Gross MW) (1) |       |      | Cost (thousands) (2) |                       |           |         | Mlk Estimated<br>Development<br>(Gross MW)(1) |             |      | Cost (thousands) (2) |                       |             |         |  |  |
|---|-----------------------------------|------------------------------------|----------------------------|--|-------|------|----------------------|-----------------------|-----------|---------|---|-------------|------|----------------------|-----------------------|-------------|---------|--|--|
|   |                                   |                                    |                            | Wells  | Plant | New  | Site Dev.            | E+C+SD+TL<br>Tran.Ln. | Tot.      | \$/kW   | Wells   | Plant       | New  | Site Dev.            | E+C+SD+TL<br>Tran.Ln. | Tot.        | \$/kW   |  |  |
| RYE01                                   | Rye Patch-Humboldt House District | Rye Patch                          | B                          | 6  | 3.5   | 6    | \$25,911             | \$9,200               | \$35,111  | \$5,852 | 10  | 7.5         | 10   | \$37,554             | \$9,200               | \$46,754    | \$4,675 |  |  |
| RYE02                                   | Rye Patch-Humboldt House District | Humboldt House                     | C                          | 27   | 27    | 27   | \$71,355             | \$16,940              | \$95,851  | \$3,550 | 34  | 34          | 34   | \$92,140             | \$16,940              | \$119,142   | \$3,504 |  |  |
| SAW00                                   | Salt Wells                        | Eight Mile Flat                    | C                          | 63   | 63    | 63   | \$143,868            | \$31,640              | \$191,492 | \$3,040 | 96  | 96          | 96   | 222,166              | \$31,640              | \$277,163   | \$2,887 |  |  |
| SOD00                                   | Soda Lake                         | Soda Lake No.1/No.2                | A                          | 13.3   | 2.9   | 13.3 | \$22,796             | \$                    | \$25,058  | \$1,884 | 26.3  | 15.9        | 26.3 | \$58,693             | \$                    | \$66,311    | \$2,521 |  |  |
| STE00                                   | Steamboat Hot Sprs                | Field-wide Summary                 | A                          | 3  | 0     | 3    | \$1,462              | \$                    | \$1,462   | \$487   | 9   | 2.16        | 9    | \$7,627              | \$                    | \$8,675     | \$964   |  |  |
| STI00                                   | Stillwater                        | Stillwater Geothermal 1            | A                          | 0  | 0     | 0    | \$                   | \$                    | \$        |         | 0   | 0           | 0    | \$                   | \$                    | \$          |         |  |  |
| STI01                                   | Stillwater                        | Stillwater N Expansion             | B                          | 11   | 16    | 16   | \$23,603             | \$                    | \$23,603  | \$1,475 | 19  | 24          | 24   | \$39,761             | \$                    | \$40,928    | \$1,705 |  |  |
| TRI00                                   | Trinity Mountains District        | Telephone Well area                | D                          | 42   | 42    | 42   | \$113,375            | \$11,460              | \$138,027 | \$3,286 | 66  | 66          | 66   | 177,585              | \$11,460              | \$209,536   | \$3,175 |  |  |
| WAB00                                   | Wabuska                           |                                    | A                          | 6.7  | 6.65  | 6.7  | \$35,127             | \$                    | \$39,150  | \$5,843 | 11.6  | 11.55       | 11.6 | \$61,341             | \$                    | \$67,299    | \$5,802 |  |  |
| Area Totals<br>and Averages (weighted): |                                   |                                    |                            | 413  | 396   | 419  | \$180,000            |                       |           |         |   | 637         | 612  | 643                  | \$180,000             |             |         |  |  |
|   |                                   |                                    |                            | \$1,196,000                                    |       |      |                      | \$1,527,000           |           |         |   | \$1,807,000 |      |                      |                       | \$2,209,000 |         |  |  |
|   |                                   |                                    |                            |  |       |      |                      | \$3,643               |           |         |   |             |      |                      |                       |             |         |  |  |
| Area: 2 - NV with direct access to CA   |                                   |                                    |                            |  |       |      |                      |                       |           |         |   |             |      |                      |                       |             |         |  |  |
| AUR00                                   | Aurora                            |                                    | C                          | 31   | 31    | 31   | \$85,866             | \$536                 | \$97,862  | \$3,157 | 51  | 51          | 51   | 139,923              | \$536                 | \$157,242   | \$3,083 |  |  |
| DIX00                                   | Dixie Valley                      | Caithness Dixie Valley             | A                          | 5  | 5     | 5    | \$14,623             | \$                    | \$19,485  | \$3,897 | 41  | 41          | 41   | 116,107              | \$                    | \$123,309   | \$3,008 |  |  |
| DIX01                                   | Dixie Valley                      | Dixie Valley Power Partners (DVPP) | C                          | 107  | 107   | 107  | \$300,684            | \$268                 | \$341,681 | \$3,193 | 151   | 151         | 151  | 421,908              | \$268                 | \$478,125   | \$3,166 |  |  |
| EMI00                                   | Emigrant (Fish Lake V.)           |                                    | C                          | 49   | 49    | 49   | \$160,152            | \$4,288               | \$186,096 | \$3,798 | 85  | 85          | 85   | 279,888              | \$4,288               | \$323,649   | \$3,808 |  |  |
| FIS00                                   | Fish Lake (Valley)                |                                    | B                          | 22.6   | 30    | 30   | \$104,355            | \$3,484               | \$112,773 | \$3,759 | 39.6  | 47          | 47   | 169,425              | \$3,484               | \$182,523   | \$3,883 |  |  |
| HAW00                                   | Hawthorne                         |                                    | C                          | 8.7  | 8.7   | 8.7  | \$32,338             | \$268                 | \$38,527  | \$4,428 | 14  | 14          | 14   | \$52,343             | \$268                 | \$61,459    | \$4,390 |  |  |
| HYD00                                   | Hyder Hot Springs                 |                                    | D                          | 5.5  | 5.5   | 5.5  | \$32,154             | \$1,716               | \$41,963  | \$7,630 | 9.6   | 9.6         | 9.6  | \$53,244             | \$1,716               | \$66,661    | \$6,944 |  |  |
| PIR00                                   | Pirouette Mountain                | (S.Dixie Valley)                   | D                          | 16   | 16    | 16   | \$44,570             | \$                    | \$50,800  | \$3,175 | 23  | 23          | 23   | \$61,241             | \$                    | \$69,979    | \$3,043 |  |  |
| SIL00                                   | Silver Peak                       | (Alum prospect)                    | C                          | 41   | 41    | 41   | \$112,925            | \$671                 | \$126,127 | \$3,076 | 78  | 78          | 78   | 207,508              | \$671                 | \$233,097   | \$2,988 |  |  |
| SOH00                                   | Sou Hot Springs                   | (Seven Devils/Gilbert's H.S.)      | D                          | 3.3  | 3.3   | 3.3  | \$11,121             | \$2,685               | \$17,342  | \$5,255 | 6.1   | 6.1         | 6.1  | \$19,435             | \$2,685               | \$25,656    | \$4,206 |  |  |
| Area Totals<br>and Averages (weighted): |                                   |                                    |                            | 289  | 297   | 297  | \$14,000             |                       |           |         |   | 498         | 506  | 506                  | \$14,000              |             |         |  |  |
|   |                                   |                                    |                            | \$899,000                                      |       |      |                      | \$1,033,000           |           |         |   | \$1,521,000 |      |                      |                       | \$1,722,000 |         |  |  |
|   |                                   |                                    |                            |  |       |      |                      | \$3,483               |           |         |   |             |      |                      |                       |             |         |  |  |

| PROJ<br>ID                              | Field or Area                 | Area or Power Plant | Explor.-<br>Devel.<br>Cat. | Min Estimated<br>Development<br>(Gross MW) (1) |       |     |           |                      |           | Mlk Estimated<br>Development<br>(Gross MW)(1) |       |     |           |                      |         |           |         |
|---|-------------------------------|---------------------|----------------------------|--|-------|-----|-----------|----------------------|-----------|---|-------|-----|-----------|----------------------|---------|-----------|---------|
|   |                               |                     |                            | Cost (thousands) (2)                           |       |     |           | Cost (thousands) (2) |           | Cost (thousands) (2)                          |       |     |           | Cost (thousands) (2) |         |           |         |
|   |                               |                     |                            | Wells  | Plant | New | Site Dev. | E+C+SD+TL            |           | Wells   | Plant | New | Site Dev. | E+C+SD+TL            |         |           |         |
|   |                               |                     |                            |  |       |     | Tran.Ln.  | Tot.                 | \$/kW     |   |       |     | Tran.Ln.  | Tot.                 | \$/kW   |           |         |
| Area: 3 - Other NV                      |                               |                     |                            |  |       |     |           |                      |           |   |       |     |           |                      |         |           |         |
| BAL00                                   | Baltazor                      |                     | C                          | 11   | 11    | 11  | \$41,628  | \$6,968              | \$56,207  | \$5,110                                       | 16    | 16  | 16        | \$64,833             | \$6,968 | \$83,201  | \$5,200 |
| DOU00                                   | Double - Black Rk Hot Springs |                     | D                          | 20   | 20    | 20  | \$81,425  | \$4,288              | \$102,600 | \$5,130                                       | 33    | 33  | 33        | \$133,837            | \$4,288 | \$164,893 | \$4,997 |
| MCG00                                   | McGee Mountain                | (Painted Hills)     | C                          | 19   | 19    | 19  | \$49,070  | \$7,504              | \$62,567  | \$3,293                                       | 28    | 28  | 28        | \$79,026             | \$7,504 | \$95,031  | \$3,394 |
| PIN00                                   | Pinto Hot Springs             |                     | D                          | 18   | 18    | 18  | \$47,570  | \$6,713              | \$60,348  | \$3,353                                       | 29    | 29  | 29        | \$74,355             | \$6,713 | \$89,641  | \$3,091 |
| SHO00                                   | Shoshone-Reese River          |                     | D                          | 13   | 13    | 13  | \$35,956  | \$4,028              | \$45,905  | \$3,531                                       | 18    | 18  | 18        | \$47,570             | \$4,028 | \$57,519  | \$3,195 |
| WIL00                                   | Wilson Hot Springs            |                     | D                          | 10   | 10    | 10  | \$23,740  | \$4,565              | \$31,295  | \$3,129                                       | 17    | 17  | 17        | \$42,980             | \$4,565 | \$52,603  | \$3,094 |
| Area Totals<br>and Averages (weighted): |                               |                     |                            | 91   | 91    | 91  | \$34,000  |                      |           |   | 141   | 141 | 141       | \$34,000             |         |           |         |
|   |                               |                     |                            |  |       |     | \$279,000 |                      | \$359,000 | \$3,944                                       |       |     |           | \$443,000            |         | \$543,000 | \$3,850 |

**Area: 4 - All other CA**

|       |                             |                                |   |      |      |     |           |          |             |         |      |      |     |           |          |             |         |  |  |
|-------|-----------------------------|--------------------------------|---|------|------|-----|-----------|----------|-------------|---------|------|------|-----|-----------|----------|-------------|---------|--|--|
| BRW01 | Brawley                     | Brawley (North Brawley)        | B | 68   | 88   | 88  | \$228,968 | \$20,900 | \$249,868   | \$2,839 | 115  | 135  | 135 | \$341,740 | \$20,900 | \$377,074   | \$2,793 |  |  |
| BRW02 | Brawley                     | East Brawley                   | B | 85   | 85   | 85  | \$312,340 | \$21,900 | \$382,103   | \$4,495 | 129  | 129  | 129 | \$464,100 | \$21,900 | \$563,015   | \$4,364 |  |  |
| BRW03 | Brawley                     | South Brawley (Mesquite field) | B | 45   | 45   | 45  | \$179,352 | \$12,900 | \$222,517   | \$4,945 | 62   | 62   | 62  | \$244,442 | \$12,900 | \$298,475   | \$4,814 |  |  |
| CAL00 | Calistoga                   |                                | C | 17   | 17   | 17  | \$54,150  | \$268    | \$61,451    | \$3,615 | 25   | 25   | 25  | \$75,700  | \$268    | \$85,336    | \$3,413 |  |  |
| COS00 | Coso                        | Field-wide Summary             | A | 0    | 0    | 0   | \$        | \$       | \$          |         | 75   | 55   | 75  | \$214,800 | \$       | \$255,406   | \$3,405 |  |  |
| DUN00 | Dunes                       |                                | C | 7.4  | 7.4  | 7.4 | \$24,325  | \$2,520  | \$30,989    | \$4,188 | 11   | 11   | 11  | \$37,660  | \$2,520  | \$47,451    | \$4,314 |  |  |
| EAS00 | East Mesa                   | Field-wide summary             | A | 57   | 45.8 | 57  | \$250,644 | \$       | \$294,307   | \$5,163 | 86   | 74.8 | 86  | \$379,051 | \$       | \$442,156   | \$5,141 |  |  |
| GEY00 | Geysers                     | Field-wide Summary             | A | 350  | 200  | 350 | \$991,684 | \$       | \$1,261,299 | \$3,604 | 550  | 400  | 550 | \$628,424 | \$       | \$2,049,009 | \$3,725 |  |  |
| GLA00 | Glamis                      |                                | D | 4.3  | 4.3  | 4.3 | \$16,645  | \$3,240  | \$24,992    | \$5,812 | 6.4  | 6.4  | 6.4 | \$26,592  | \$3,240  | \$34,939    | \$5,459 |  |  |
| HEB00 | Heber                       | Field-wide Summary             | A | 9    | 9    | 9   | \$28,809  | \$       | \$30,780    | \$3,420 | 42   | 42   | 42  | \$104,334 | \$       | \$113,651   | \$2,706 |  |  |
| LAK00 | Lake City / Surprise Valley | Lake City                      | B | 20.5 | 23   | 23  | \$67,305  | \$6,700  | \$79,361    | \$3,450 | 34.5 | 37   | 37  | \$105,801 | \$6,700  | \$123,103   | \$3,327 |  |  |
| LVM00 | Long Valley - M-P Leases    | M-P Lease Summary              | A | 30   | 30   | 30  | \$11,557  | \$       | \$17,395    | \$580   | 71   | 71   | 71  | \$133,170 | \$       | \$144,424   | \$2,034 |  |  |
| MED01 | Medicine Lake               | Fourmile Hill                  | B | 25   | 25   | 25  | \$60,604  | \$5,896  | \$73,513    | \$2,941 | 36   | 36   | 36  | \$85,768  | \$5,896  | \$102,167   | \$2,838 |  |  |
| MED02 | Medicine Lake               | Telephone Flat                 | B | 95   | 110  | 110 | \$230,702 | \$5,896  | \$245,820   | \$2,235 | 160  | 175  | 175 | \$373,688 | \$5,896  | \$403,974   | \$2,308 |  |  |
| MOS00 | Mount Signal                |                                | C | 12   | 12   | 12  | \$32,909  | \$900    | \$36,637    | \$3,053 | 19   | 19   | 19  | \$47,136  | \$900    | \$53,066    | \$2,793 |  |  |
| NIL00 | Niland                      |                                | B | 59   | 59   | 59  | \$165,178 | \$10,900 | \$197,340   | \$3,345 | 76   | 76   | 76  | \$217,706 | \$10,900 | \$257,840   | \$3,393 |  |  |

| PROJ<br>ID                                       | Field or Area         | Area or Power Plant | Explor.-<br>Devel.<br>Cat. | Min Estimated<br>Development<br>(Gross MW) (1) |       |      | Cost (thousands) (2) |                       |             |         | Mlk Estimated<br>Development<br>(Gross MW)(1) |       |      | Cost (thousands) (2) |                       |              |         |
|--|-----------------------|---------------------|----------------------------|--|-------|------|----------------------|-----------------------|-------------|---------|---|-------|------|----------------------|-----------------------|--------------|---------|
|  |                       |                     |                            | Wells  | Plant | New  | Site Dev.            | E+C+SD+TL<br>Tran.Ln. | Tot.        | \$/kW   | Wells   | Plant | New  | Site Dev.            | E+C+SD+TL<br>Tran.Ln. | Tot.         | \$/kW   |
| RAN00  | Randsburg             |                     | C                          | 32   | 32    | 32   | \$79,820             | \$5,360               | \$93,413    | \$2,919 | 48  | 48    | 48   | \$113,366            | \$5,360               | \$130,872    | \$2,727 |
| SAL00  | Salton Sea            | Field-wide summary  | A                          | 1000   | 1000  | 1000 | 2,125,089            | \$184,500             | 2,445,654   | \$2,446 | 1400  | 1400  | 1400 | 967,552              | \$184,500             | 3,334,333    | \$2,382 |
| SES00  | Sespe Hot Springs     |                     | D                          | 3.6  | 3.6   | 3.6  | \$15,685             | \$4,028               | \$23,273    | \$6,465 | 5.3   | 5.3   | 5.3  | \$18,235             | \$4,028               | \$25,823     | \$4,872 |
| SUL00  | Sulphur Bank          | Clear Lake          | B                          | 27   | 27    | 27   | \$56,997             | \$537                 | \$62,051    | \$2,298 | 43  | 43    | 43   | \$91,995             | \$537                 | \$101,461    | \$2,360 |
| SUP00  | Superstition Mountain |                     | D                          | 5.9  | 5.9   | 5.9  | \$15,021             | \$1,611               | \$20,096    | \$3,406 | 9.5   | 9.5   | 9.5  | \$24,535             | \$1,611               | \$32,118     | \$3,381 |
| <b>Area Totals<br/>and Averages (weighted):</b>  |                       |                     |                            | 1953   | 1829  | 1990 | \$288,000            |                       |             |         | 3004  | 2860  | 3041 | \$288,000            |                       |              |         |
|  |                       |                     |                            |  |       |      | \$4,948,000          |                       | \$5,853,000 | \$2,941 |   |       |      | \$7,696,000          |                       | \$8,976,000  | \$2,951 |
| <b>Grand Totals :</b>                            |                       |                     |                            | 2746   | 2613  | 2797 |                      |                       |             |         | 4280  | 4119  | 4331 |                      |                       |              |         |
| <b>Grand Totals<br/>and Averages (weighted):</b> |                       |                     |                            |  |       |      | \$7,322,000          |                       | \$8,772,000 |         |   |       |      | \$11,467,000         |                       | \$13,449,000 |         |
|  |                       |                     |                            |  |       |      | \$516,000            |                       | \$3,136     |         |   |       |      | \$516,000            |                       | \$3,106      |         |

**Notes:**

(1) Gross MW of new wellhead production capacity and of new plant capacity needed to bring total electricity generation to the Minimum (Min) or Most-likely (Modal or Mlk) estimated generation capacity of the resource. The well and plant figures differ if there is existing unused (but proven) wellhead production capacity, or existing under-utilized plant capacity. A value of 0 indicates that the existing wellfield production capacity or plant capacity is very close to or exceeds the corresponding generation capacity estimate, so that no confirmation or development is planned and costed. "New" is the larger of wellhead MW or plant MW and represents the total increment of electricity production to be expected. Development costs are actually calculated on the basis of drilling and proving 105% of needed gross MW, so that a reserve capacity is available.

(2) E+C+SD+TL = Exploration + Confirmation + Site Development + Transmission Line. Costs/kW are calculated with respect to new gross MW.

**Hetch Hetchy/SFPUC Programmatic Renewable Energy Project**

**Project:** 1.3 New Geothermal Site Identification and Qualification

**Project Team:** GeothermEx, Inc.

**Task:** 1.3.10 Final Project Report

**Subject:** D.1.3.10.3 Final Report

***Table 15. Total and Incremental Generation Capacities for Selected Areas <sup>1</sup>***

| <i>Area</i>      | <i>Minimum<br/>Total<br/>Generation Capacity<br/>(Gross MW)</i> | <i>Most-likely<br/>Total<br/>Generation Capacity<br/>(Gross MW)</i> | <i>Minimum<br/>Incremental<br/>Generation Capacity<br/>(Gross MW)</i> | <i>Most-likely<br/>Incremental<br/>Generation Capacity<br/>(Gross MW)</i> | <i>Percentage<br/>of<br/>State Total</i> | <i>Percentage<br/>of<br/>Grand Total</i> |
|------------------|---|---|---|---|--|--|
| California       |   |   |   |   |  |  |
| Imperial Valley  | 1,900   | 2,500   | 1,350   | 1,950   | 65%                                      | 45%                                      |
| The Geysers      | 1,200   | 1,400   | 350   | 550   | 18%                                      | 13%                                      |
| Medicine Lake    | 150   | 200   | 150   | 200   | 7%                                       | 5%                                       |
| Other            | <u>450</u>  | <u>600</u>  | <u>150</u>  | <u>300</u>  | <u>10%</u>                               | 7%                                       |
| California Total | 3,700   | 4,700   | 2,000   | 3,000   | 100%                                     | 70%                                      |
| Nevada           |   |   |   |   |  |  |
| Greater Reno     | 550   | 800   | 400   | 650   | 50%                                      | 15%                                      |
| Dixie Corridor   | 350   | 550   | 300   | 500   | 38%                                      | 12%                                      |
| Other            | <u>100</u>  | <u>150</u>  | <u>100</u>  | <u>150</u>  | <u>12%</u>                               | 3%                                       |
| Nevada Total     | 1,000   | 1,500   | 800   | 1,300   | 100%                                     | 30%                                      |
| Grand Total      | <u>4,700</u>  | <u>6,200</u>  | <u>2,800</u>  | <u>4,300</u>  | -  | 100%                                     |

Note: (1) The data in this table are derived from the Area totals in Tables 3 and 12, rounded to the nearest increment of 50 MW.

**Hetch Hetchy/SFPUC Programmatic Renewable Energy Project**  
**Project: 1.3 New Geothermal Site Identification and Qualification**  
**Project Team: GeothermEx, Inc.**  
**Task: 1.3.9 Estimate Development Costs**  
**Subject: D.1.3.9.1 Total and Normalized Development Cost Database for Non-HVDC Area**

***Appendix 2. Site Development, Transmission Line and Total Cost Estimates - Totals and per kW***

| PROJ<br>ID                         | Field or Area                   | Area or Power Plant            | Explor.-<br>Devel.<br>Cat. | Min Estimated<br>Development<br>(Gross MW) (1) |       |     | Cost (thousands) (2) |          |                   |          | Mlk Estimated<br>Development<br>(Gross MW)(1) |       |      | Cost (thousands) (2) |          |                   |         |          |         |
|------------------------------------|---------------------------------|--------------------------------|----------------------------|--|-------|-----|----------------------|----------|-------------------|----------|---|-------|------|----------------------|----------|-------------------|---------|----------|---------|
|                                    |                                 |                                |                            | Wells  | Plant | New | Site Dev.            | Tran.Ln. | E+C+SD+TL<br>Tot. | \$/kW    | Wells   | Plant | New  | Site Dev.            | Tran.Ln. | E+C+SD+TL<br>Tot. | \$/kW   |          |         |
| Area: 1 - Greater Reno (NV and CA) |                                 |                                |                            |  |       |     |                      |          |                   |          |   |       |      |                      |          |                   |         |          |         |
| BEO00                              | Beowawe                         |                                | A                          | 15   | 13.3  | 15  | \$48,048             |          | \$                | \$52,978 | \$3,532                                       | 26    | 24.3 | 26                   | \$84,618 |                   | \$      | \$94,293 | \$3,627 |
| BLU00                              | Blue Mountain                   |                                | C                          | 16   | 16    | 16  | \$36,376             | \$14,510 | \$54,044          | \$3,378  | 30  | 30    | 30   | \$67,277             | \$14,510 | \$87,947          | \$2,932 |          |         |
| BRA00                              | Brady's Hot Springs             |                                | A                          | 0  | 0     | 0   |                      | \$       |                   | \$       |   | 3     | 0    | 3                    | \$7,233  |                   | \$      | \$10,160 | \$3,387 |
| COL00                              | Colado                          |                                | C                          | 3.7  | 3.7   | 3.7 | \$13,600             | \$3,650  | \$20,260          | \$5,476  | 6.2   | 6.2   | 6.2  | \$22,180             | \$3,650  | \$28,840          | \$4,652 |          |         |
| DES00                              | Desert Peak                     |                                | A                          | 23   | 22    | 23  | \$54,703             |          | \$                | \$59,551 | \$2,589                                       | 35    | 34   | 35                   | \$82,568 |                   | \$      | \$89,825 | \$2,566 |
| EMP00                              | Empire (San Emidio)             | Field-wide summary             | A                          | 0  | 0     | 0   |                      | \$       |                   | \$       |   | 1.8   | 1.8  | 1.8                  | \$6,276  |                   | \$      | \$7,869  | \$4,372 |
| FAL00                              | Fallon / Carson Lake            | Carson Lake anomaly            | C                          | 34   | 34    | 34  | \$94,956             | \$12,410 | \$119,222         | \$3,507  | 55  | 55    | 55   | 145,992              | \$12,410 | \$176,185         | \$3,203 |          |         |
| FLY00                              | Fly Ranch/Granite Ranch         | Ward's (Fly/Hualapi Flat) H.S. | C                          | 6  | 6     | 6   | \$43,212             | \$3,660  | \$58,923          | \$9,821  | 8.7   | 8.7   | 8.7  | \$66,480             | \$3,660  | \$86,121          | \$9,899 |          |         |
| FLY01                              | Fly Ranch/Granite Ranch         | Granite Ranch                  | C                          | 5.4  | 5.4   | 5.4 | \$14,271             | \$3,660  | \$21,147          | \$3,916  | 8.1   | 8.1   | 8.1  | \$22,435             | \$3,660  | \$29,311          | \$3,619 |          |         |
| GER00                              | Gerlach                         | (Great Boiling Spring)         | C                          | 17   | 17    | 17  | \$55,380             | \$7,280  | \$69,946          | \$4,114  | 25  | 25    | 25   | \$82,320             | \$7,280  | \$100,494         | \$4,020 |          |         |
| HAZ00                              | Hazen (Black Butte)             | (Patua Hot Springs)            | C                          | 6.3  | 6.3   | 6.3 | \$21,402             | \$5,730  | \$31,145          | \$4,944  | 8.5   | 8.5   | 8.5  | \$24,702             | \$5,730  | \$34,445          | \$4,052 |          |         |
| HON00                              | Honey Lake                      | Area-wide Summary              | A                          | 4.5  | 0     | 4.5 | \$10,368             |          | \$                | \$12,084 | \$2,685                                       | 7.1   | 1.9  | 7.1                  | \$15,810 |                   | \$      | \$19,059 | \$2,684 |
| KYL00                              | Kyle Hot Springs (Granite Mtn.) | (Buena Vista Valley)           | C                          | 16   | 16    | 16  | \$47,904             | \$10,630 | \$66,606          | \$4,163  | 22  | 22    | 22   | \$62,880             | \$10,630 | \$81,582          | \$3,708 |          |         |
| LEA00                              | Leach Hot Springs               | Grass Valley                   | C                          | 13   | 13    | 13  | \$70,560             | \$9,160  | \$92,456          | \$7,112  | 18  | 18    | 18   | \$95,080             | \$9,160  | \$121,077         | \$6,727 |          |         |
| LEE00                              | Lee Hot Springs                 |                                | C                          | 5.4  | 5.4   | 5.4 | \$18,385             | \$5,960  | \$27,905          | \$5,168  | 9.4   | 9.4   | 9.4  | \$30,556             | \$5,960  | \$40,076          | \$4,263 |          |         |
| NEW00                              | New York Canyon                 |                                | C                          | 20   | 20    | 20  | \$56,741             | \$12,800 | \$75,774          | \$3,789  | 26  | 26    | 26   | \$69,855             | \$12,800 | \$91,396          | \$3,515 |          |         |
| NOR00                              | North Valley                    |                                | C                          | 37   | 37    | 37  | \$95,704             | \$7,020  | \$113,671         | \$3,072  | 49  | 49    | 49   | 124,192              | \$7,020  | \$144,301         | \$2,945 |          |         |
| PUM00                              | Pumpnickel Valley               | Tipton Ranch/Hot Springs Ranch | C                          | 9.1  | 10    | 10  | \$32,496             | \$8,500  | \$43,905          | \$4,391  | 12.1  | 13    | 13   | \$41,370             | \$8,500  | \$55,367          | \$4,259 |          |         |
| PYR00                              | Pyramid Lake Indian Reserv.     | (Needle Rocks Hot Springs)     | C                          | 9.9  | 9.9   | 9.9 | \$28,075             | \$5,628  | \$37,154          | \$3,753  | 14  | 14    | 14   | \$42,160             | \$5,628  | \$54,366          | \$3,883 |          |         |

| PROJ<br>ID                                      | Field or Area                     | Area or Power Plant     | Explor.-<br>Devel.<br>Cat. | Min Estimated<br>Development<br>(Gross MW) (1)<br>Cost (thousands) (2) |       |      |           |             |                   |         |  | Mlk Estimated<br>Development<br>(Gross MW)(1)<br>Cost (thousands) (2) |       |      |           |             |                   |         |  |
|---|-----------------------------------|-------------------------|----------------------------|--|-------|------|-----------|-------------|-------------------|---------|--|---|-------|------|-----------|-------------|-------------------|---------|--|
|   |                                   |                         |                            | Wells  | Plant | New  | Site Dev. | Tran.Ln.    | E+C+SD+TL<br>Tot. | \$/kW   |  | Wells   | Plant | New  | Site Dev. | Tran.Ln.    | E+C+SD+TL<br>Tot. | \$/kW   |  |
| RYE01   | Rye Patch-Humboldt House District | Rye Patch               | B                          | 6  | 3.5   | 6    | \$25,911  | \$9,200     | \$35,111          | \$5,852 |  | 10  | 7.5   | 10   | \$37,554  | \$9,200     | \$46,754          | \$4,675 |  |
| RYE02   | Rye Patch-Humboldt House District | Humboldt House          | C                          | 27   | 27    | 27   | \$71,355  | \$16,940    | \$95,851          | \$3,550 |  | 34  | 34    | 34   | \$92,140  | \$16,940    | \$119,142         | \$3,504 |  |
| SAW00   | Salt Wells                        | Eight Mile Flat         | C                          | 63   | 63    | 63   | \$143,868 | \$31,640    | \$191,492         | \$3,040 |  | 96  | 96    | 96   | 222,166   | \$31,640    | \$277,163         | \$2,887 |  |
| SOD00   | Soda Lake                         | Soda Lake No.1/No.2     | A                          | 13.3   | 2.9   | 13.3 | \$22,796  | \$          | \$25,058          | \$1,884 |  | 26.3  | 15.9  | 26.3 | \$58,693  | \$          | \$66,311          | \$2,521 |  |
| STE00   | Steamboat Hot Sprs                | Field-wide Summary      | A                          | 3  | 0     | 3    | \$1,462   | \$          | \$1,462           | \$487   |  | 9   | 2.16  | 9    | \$7,627   | \$          | \$8,675           | \$964   |  |
| STI00   | Stillwater                        | Stillwater Geothermal 1 | A                          | 0  | 0     | 0    | \$        | \$          | \$                |         |  | 0   | 0     | 0    | \$        | \$          | \$                |         |  |
| STI01   | Stillwater                        | Stillwater N Expansion  | B                          | 11   | 16    | 16   | \$23,603  | \$          | \$23,603          | \$1,475 |  | 19  | 24    | 24   | \$39,761  | \$          | \$40,928          | \$1,705 |  |
| TRI00   | Trinity Mountains District        | Telephone Well area     | D                          | 42   | 42    | 42   | \$113,375 | \$11,460    | \$138,027         | \$3,286 |  | 66  | 66    | 66   | 177,585   | \$11,460    | \$209,536         | \$3,175 |  |
| WAB00   | Wabuska                           |                         | A                          | 6.7  | 6.65  | 6.7  | \$35,127  | \$          | \$39,150          | \$5,843 |  | 11.6  | 11.55 | 11.6 | \$61,341  | \$          | \$67,299          | \$5,802 |  |
| <b>Area Totals<br/>and Averages (weighted):</b> |                                   |                         |                            | 413  | 396   | 419  | \$180,000 |             |                   |         |  | 637   | 612   | 643  | \$180,000 |             |                   |         |  |
|   |                                   |                         |                            | \$1,180,000  |       |      |           | \$1,507,000 |                   |         |  | \$1,791,000   |       |      |           | \$2,189,000 |                   |         |  |
|   |                                   |                         |                            |  |       |      |           | \$3,594     |                   |         |  |   |       |      |           |             |                   |         |  |

**Area: 2 - NV with direct access to CA**

|   |                         |                                    |   |           |     |     |           |             |           |         |  |             |     |     |          |             |           |         |  |
|---|-------------------------|------------------------------------|---|-----------|-----|-----|-----------|-------------|-----------|---------|--|-------------|-----|-----|----------|-------------|-----------|---------|--|
| AUR00   | Aurora                  |                                    | C | 31        | 31  | 31  | \$85,866  | \$536       | \$97,862  | \$3,157 |  | 51          | 51  | 51  | 139,923  | \$536       | \$157,242 | \$3,083 |  |
| DIX00   | Dixie Valley            | Caithness Dixie Valley             | A | 5         | 5   | 5   | \$14,623  | \$          | \$19,485  | \$3,897 |  | 41          | 41  | 41  | 116,107  | \$          | \$123,309 | \$3,008 |  |
| DIX01   | Dixie Valley            | Dixie Valley Power Partners (DVPP) | C | 107       | 107 | 107 | \$300,684 | \$268       | \$341,681 | \$3,193 |  | 151         | 151 | 151 | 421,908  | \$268       | \$478,125 | \$3,166 |  |
| EMI00   | Emigrant (Fish Lake V.) |                                    | C | 49        | 49  | 49  | \$160,152 | \$4,288     | \$186,096 | \$3,798 |  | 85          | 85  | 85  | 279,888  | \$4,288     | \$323,649 | \$3,808 |  |
| FIS00   | Fish Lake (Valley)      |                                    | B | 22.6      | 30  | 30  | \$104,355 | \$3,484     | \$112,773 | \$3,759 |  | 39.6        | 47  | 47  | 169,425  | \$3,484     | \$182,523 | \$3,883 |  |
| HAW00   | Hawthorne               |                                    | C | 8.7       | 8.7 | 8.7 | \$32,338  | \$268       | \$38,527  | \$4,428 |  | 14          | 14  | 14  | \$52,343 | \$268       | \$61,459  | \$4,390 |  |
| HYD00   | Hyder Hot Springs       |                                    | D | 5.5       | 5.5 | 5.5 | \$32,154  | \$1,716     | \$41,963  | \$7,630 |  | 9.6         | 9.6 | 9.6 | \$53,244 | \$1,716     | \$66,661  | \$6,944 |  |
| PIR00   | Pirouette Mountain      | (S.Dixie Valley)                   | D | 16        | 16  | 16  | \$44,570  | \$          | \$50,800  | \$3,175 |  | 23          | 23  | 23  | \$61,241 | \$          | \$69,979  | \$3,043 |  |
| SIL00   | Silver Peak             | (Alum prospect)                    | C | 41        | 41  | 41  | \$112,925 | \$671       | \$126,127 | \$3,076 |  | 78          | 78  | 78  | 207,508  | \$671       | \$233,097 | \$2,988 |  |
| SOH00   | Sou Hot Springs         | (Seven Devils/Gilbert's H.S.)      | D | 3.3       | 3.3 | 3.3 | \$11,121  | \$2,685     | \$17,342  | \$5,255 |  | 6.1         | 6.1 | 6.1 | \$19,435 | \$2,685     | \$25,656  | \$4,206 |  |
| <b>Area Totals<br/>and Averages (weighted):</b> |                         |                                    |   | 289       | 297 | 297 | \$14,000  |             |           |         |  | 498         | 506 | 506 | \$14,000 |             |           |         |  |
|   |                         |                                    |   | \$899,000 |     |     |           | \$1,033,000 |           |         |  | \$1,521,000 |     |     |          | \$1,722,000 |           |         |  |
|   |                         |                                    |   |           |     |     |           | \$3,483     |           |         |  |             |     |     |          |             |           |         |  |

| PROJ<br>ID                              | Field or Area                 | Area or Power Plant | Explor.-<br>Devel.<br>Cat. | Min Estimated<br>Development<br>(Gross MW) (1) |       |     |           |           |           | Mlk Estimated<br>Development<br>(Gross MW)(1) |         |     |           |           |           |           |         |           |         |
|---|-------------------------------|---------------------|----------------------------|--|-------|-----|-----------|-----------|-----------|---|---------|-----|-----------|-----------|-----------|-----------|---------|-----------|---------|
|   |                               |                     |                            | Cost (thousands) (2)                           |       |     |           |           |           | Cost (thousands) (2)                          |         |     |           |           |           |           |         |           |         |
|   |                               |                     |                            | Wells  | Plant | New | Site Dev. | E+C+SD+TL |           | Wells   | Plant   | New | Site Dev. | E+C+SD+TL |           |           |         |           |         |
|   |                               |                     |                            |  |       |     | Tran.Ln.  | Tot.      | \$/kW     |   |         |     | Tran.Ln.  | Tot.      | \$/kW     |           |         |           |         |
| Area: 3 - Other NV                      |                               |                     |                            |  |       |     |           |           |           |   |         |     |           |           |           |           |         |           |         |
| BAL00                                   | Baltazor                      |                     | C                          | 11   | 11    | 11  | \$41,628  | \$6,968   | \$56,207  | \$5,110                                       | 16      | 16  | 16        | \$64,833  | \$6,968   | \$83,201  | \$5,200 |           |         |
| DOU00                                   | Double - Black Rk Hot Springs |                     | D                          | 20   | 20    | 20  | \$81,425  | \$4,288   | \$102,600 | \$5,130                                       | 33      | 33  | 33        | \$133,837 | \$4,288   | \$164,893 | \$4,997 |           |         |
| MCG00                                   | McGee Mountain                | (Painted Hills)     | C                          | 19   | 19    | 19  | \$49,070  | \$7,504   | \$62,567  | \$3,293                                       | 28      | 28  | 28        | \$79,026  | \$7,504   | \$95,031  | \$3,394 |           |         |
| PIN00                                   | Pinto Hot Springs             |                     | D                          | 18   | 18    | 18  | \$47,570  | \$6,713   | \$60,348  | \$3,353                                       | 29      | 29  | 29        | \$74,355  | \$6,713   | \$89,641  | \$3,091 |           |         |
| SHO00                                   | Shoshone-Reese River          |                     | D                          | 13   | 13    | 13  | \$35,956  | \$4,028   | \$45,905  | \$3,531                                       | 18      | 18  | 18        | \$47,570  | \$4,028   | \$57,519  | \$3,195 |           |         |
| WIL00                                   | Wilson Hot Springs            |                     | D                          | 10   | 10    | 10  | \$23,740  | \$4,565   | \$31,295  | \$3,129                                       | 17      | 17  | 17        | \$42,980  | \$4,565   | \$52,603  | \$3,094 |           |         |
| Area Totals<br>and Averages (weighted): |                               |                     |                            | 91   | 91    | 91  | \$34,000  |           |           |   | 141     | 141 | 141       | \$34,000  |           |           |         |           |         |
|   |                               |                     |                            |  |       |     | \$279,000 |           |           | \$359,000                                     | \$3,944 |     |           |           | \$443,000 |           |         | \$543,000 | \$3,850 |

#### Area: 4 - All other CA

|       |                             |                                |   |      |      |     |           |          |             |         |      |      |     |           |          |             |         |
|-------|-----------------------------|--------------------------------|---|------|------|-----|-----------|----------|-------------|---------|------|------|-----|-----------|----------|-------------|---------|
| BRW01 | Brawley                     | Brawley (North Brawley)        | B | 68   | 88   | 88  | \$228,968 | \$20,900 | \$249,868   | \$2,839 | 115  | 135  | 135 | \$341,740 | \$20,900 | \$377,074   | \$2,793 |
| BRW02 | Brawley                     | East Brawley                   | B | 85   | 85   | 85  | \$312,340 | \$21,900 | \$382,103   | \$4,495 | 129  | 129  | 129 | \$464,100 | \$21,900 | \$563,015   | \$4,364 |
| BRW03 | Brawley                     | South Brawley (Mesquite field) | B | 45   | 45   | 45  | \$179,352 | \$12,900 | \$222,517   | \$4,945 | 62   | 62   | 62  | \$244,442 | \$12,900 | \$298,475   | \$4,814 |
| CAL00 | Calistoga                   |                                | C | 17   | 17   | 17  | \$54,150  | \$268    | \$61,451    | \$3,615 | 25   | 25   | 25  | \$75,700  | \$268    | \$85,336    | \$3,413 |
| COS00 | Coso                        | Field-wide Summary             | A | 0    | 0    | 0   | \$        | \$       | \$          |         | 75   | 55   | 75  | \$214,800 | \$       | \$255,406   | \$3,405 |
| DUN00 | Dunes                       |                                | C | 7.4  | 7.4  | 7.4 | \$24,325  | \$2,520  | \$30,989    | \$4,188 | 11   | 11   | 11  | \$37,660  | \$2,520  | \$47,451    | \$4,314 |
| EAS00 | East Mesa                   | Field-wide summary             | A | 57   | 45.8 | 57  | \$250,644 | \$       | \$294,307   | \$5,163 | 86   | 74.8 | 86  | \$379,051 | \$       | \$442,156   | \$5,141 |
| GEY00 | Geysers                     | Field-wide Summary             | A | 350  | 200  | 350 | \$991,684 | \$       | \$1,261,299 | \$3,604 | 550  | 400  | 550 | \$628,424 | \$       | \$2,049,009 | \$3,725 |
| GLA00 | Glamis                      |                                | D | 4.3  | 4.3  | 4.3 | \$16,645  | \$3,240  | \$24,992    | \$5,812 | 6.4  | 6.4  | 6.4 | \$26,592  | \$3,240  | \$34,939    | \$5,459 |
| HEB00 | Heber                       | Field-wide Summary             | A | 9    | 9    | 9   | \$28,809  | \$       | \$30,780    | \$3,420 | 42   | 42   | 42  | \$104,334 | \$       | \$113,651   | \$2,706 |
| LAK00 | Lake City / Surprise Valley | Lake City                      | B | 20.5 | 23   | 23  | \$67,305  | \$6,700  | \$79,361    | \$3,450 | 34.5 | 37   | 37  | \$105,801 | \$6,700  | \$123,103   | \$3,327 |
| LVM00 | Long Valley - M-P Leases    | M-P Lease Summary              | A | 30   | 30   | 30  | \$11,557  | \$       | \$17,395    | \$580   | 71   | 71   | 71  | \$133,170 | \$       | \$144,424   | \$2,034 |
| MED01 | Medicine Lake               | Fourmile Hill                  | B | 25   | 25   | 25  | \$60,604  | \$5,896  | \$73,513    | \$2,941 | 36   | 36   | 36  | \$85,768  | \$5,896  | \$102,167   | \$2,838 |
| MED02 | Medicine Lake               | Telephone Flat                 | B | 95   | 110  | 110 | \$230,702 | \$5,896  | \$245,820   | \$2,235 | 160  | 175  | 175 | \$373,688 | \$5,896  | \$403,974   | \$2,308 |
| MOS00 | Mount Signal                |                                | C | 12   | 12   | 12  | \$32,909  | \$900    | \$36,637    | \$3,053 | 19   | 19   | 19  | \$47,136  | \$900    | \$53,066    | \$2,793 |
| NIL00 | Niland                      |                                | B | 59   | 59   | 59  | \$165,178 | \$10,900 | \$197,340   | \$3,345 | 76   | 76   | 76  | \$217,706 | \$10,900 | \$257,840   | \$3,393 |

| PROJ<br>ID                      | Field or Area         | Area or Power Plant | Explor.-<br>Devel.<br>Cat. | Min Estimated<br>Development<br>(Gross MW) (1) |       |      | Cost (thousands) (2) |           |             |         | Mlk Estimated<br>Development<br>(Gross MW)(1) |       |      | Cost (thousands) (2) |           |              |         |
|---------------------------------|-----------------------|---------------------|----------------------------|--|-------|------|----------------------|-----------|-------------|---------|---|-------|------|----------------------|-----------|--------------|---------|
|                                 |                       |                     |                            | Wells  | Plant | New  | Site Dev.            | E+C+SD+TL |             |         | Wells   | Plant | New  | Site Dev.            | E+C+SD+TL |              |         |
|                                 |                       |                     |                            |  |       |      | Tran.Ln.             | Tot.      | \$/kW       |         |   |       |      | Tran.Ln.             | Tot.      | \$/kW        |         |
| RAN00                           | Randsburg             |                     | C                          | 32   | 32    | 32   | \$79,820             | \$5,360   | \$93,413    | \$2,919 | 48  | 48    | 48   | \$113,366            | \$5,360   | \$130,872    | \$2,727 |
| SAL00                           | Salton Sea            | Field-wide summary  | A                          | 1000   | 1000  | 1000 | 2,125,089            | \$184,500 | 2,445,654   | \$2,446 | 1400  | 1400  | 1400 | 967,552              | \$184,500 | 3,334,333    | \$2,382 |
| SES00                           | Sespe Hot Springs     |                     | D                          | 3.6  | 3.6   | 3.6  | \$15,685             | \$4,028   | \$23,273    | \$6,465 | 5.3   | 5.3   | 5.3  | \$18,235             | \$4,028   | \$25,823     | \$4,872 |
| SUL00                           | Sulphur Bank          | Clear Lake          | B                          | 27   | 27    | 27   | \$56,997             | \$537     | \$62,051    | \$2,298 | 43  | 43    | 43   | \$91,995             | \$537     | \$101,461    | \$2,360 |
| SUP00                           | Superstition Mountain |                     | D                          | 5.9  | 5.9   | 5.9  | \$15,021             | \$1,611   | \$20,096    | \$3,406 | 9.5   | 9.5   | 9.5  | \$24,535             | \$1,611   | \$32,118     | \$3,381 |
| <b>Area Totals</b>              |                       |                     |                            | 1953   | 1829  | 1990 | \$288,000            |           |             |         | 3004  | 2860  | 3041 | \$288,000            |           |              |         |
| <b>and Averages (weighted):</b> |                       |                     |                            |  |       |      | \$4,948,000          |           | \$5,853,000 | \$2,941 |   |       |      | \$7,696,000          |           | \$8,976,000  | \$2,951 |
| <b>Grand Totals :</b>           |                       |                     |                            | 2746   | 2613  | 2797 |                      |           |             |         | 4280  | 4119  | 4331 |                      |           |              |         |
| <b>Grand Totals</b>             |                       |                     |                            |  |       |      | \$7,306,000          |           | \$8,751,000 |         |   |       |      | \$11,450,000         |           | \$13,429,000 |         |
| <b>and Averages (weighted):</b> |                       |                     |                            |  |       |      | \$516,000            |           | \$3,129     |         |   |       |      | \$516,000            |           | \$3,101      |         |

**Notes:**

(1) Gross MW of new wellhead production capacity and of new plant capacity needed to bring total electricity generation to the Minimum (Min) or Most-likely (Modal or Mlk) estimated generation capacity of the resource. The well and plant figures differ if there is existing unused (but proven) wellhead production capacity, or existing under-utilized plant capacity. A value of 0 indicates that the existing wellfield production capacity or plant capacity is very close to or exceeds the corresponding generation capacity estimate, so that no confirmation or development is planned and costed. "New" is the larger of wellhead MW or plant MW and represents the total increment of electricity production to be expected. Development costs are actually calculated on the basis of drilling and proving 105% of needed gross MW, so that a reserve capacity is available.

(2) E+C+SD+TL = Exploration + Confirmation + Site Development + Transmission Line. Costs/kW are calculated with respect to new gross MW.